

JOHN GEORGE WOOD

NATURE'S TEACHINGS

John George Wood
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J. G. Wood

Nature's Teachings / Human Invention Anticipated by Nature

PREFACE

A GLANCE at almost any page of this work will denote its object. It is to show the close connection between Nature and human inventions, and that there is scarcely an invention of man that has not its prototype in Nature. And it is worthy of notice that the greatest results have been obtained from means apparently the most insignificant.

There are two inventions, for example, which have changed the face of the earth, and which yet sprang from sources that were despised by men, and thought only fit for the passing sport of childhood. I allude, of course, to Steam and Electricity, both of which had been child's toys for centuries before the one gave us the fixed engine, the locomotive, and the steamboat, and the other supplied us with the compass and the electric telegraph.

In the course of this work I have placed side by side a great number of parallels of Nature and Art, making the descriptions as terse and simple as possible, and illustrating them with more than seven hundred and fifty figures. The corollary which I hope will be drawn from the work is evident enough. It is, that as existing human inventions have been anticipated by Nature, so it will surely be found that in Nature lie the prototypes of inventions not yet revealed to man. The great discoverers of the future will, therefore, be those who will look to Nature for Art, Science, or Mechanics, instead of taking pride in some new invention, and then finding that it has existed in Nature for countless centuries.

I ought to mention that the illustrations are not intended to be finished drawings, but merely charts or maps, calling attention to the salient points.

NAUTICAL

CHAPTER I

Poetry and Science.—The Paper Nautilus and the Sail.—Montgomery's "Pelican Island."—The Nautilus replaced by the Velella.—The Sailing Raft of Nature and Art.—Description of a Velella Fleet off Tenby.—The Natural Raft and its Sail.—The Boats of Nature and Art.—Man's first Idea of a Boat.—The Kruman's Canoe and the *Great Eastern*.—Gradual Development of the Boat.—The Outrigger Canoe a Mixture of Raft and Boat.—Natural Boats.—The Water-snails.—The Sea-anemones.—The Egg-boat of the Gnat.—The Skin-boat of the same Insect.—Shape and Properties of the Life-boat anticipated in Nature.—Natural Boat of the Stratiomys.

The Raft

IT has been frequently said that the modern developments of science are gradually destroying many of the poetical elements of our daily lives, and in consequence are reducing us to a dead level of prosaic commonplace, in which existence is scarcely worth having. The first part of this rather sweeping assertion is perfectly true, but, as we shall presently see, the second portion is absolutely untrue.

Science has certainly destroyed, and is destroying, many of the poetic fancies which made a part of daily life. It must have been a considerable shock to the mind of an ancient philosopher when he found himself deprived of the semi-spiritual, semi-human beings with which the earth and water were thought to be peopled. And even in our own time and country there is in many places a still lingering belief in the existence of good and bad fairies inhabiting lake, wood, and glen, the successors of the Naiads and Dryads, the Fauns and Satyrs, of the former time. Many persons will doubtless be surprised, even in these days, to hear that the dreaded Maelström is quite as fabulous as the Symplegades or Scylla and Charybdis, and that the well-known tale of Edgar Poe is absolutely without foundation.

Perhaps one of the prettiest legends in natural history is that of the Paper Nautilus, with which so much poetry is associated. We have all been accustomed from childhood to Pope's well-known lines beginning—

"Learn of the little Nautilus to sail,"

and some of us may be acquainted with those graceful verses of James Montgomery, in his "Pelican Island:"—

"Light as a flake of foam upon the wind,
Keel upward, from the deep emerged a shell,
Shaped like the moon ere half her horn is filled.
Fraught with young life it righted as it rose,
And moved at will along the yielding water.
The native pilot of this little bark
Put out a tier of oars on either side,

Spread to the wafting breeze a two-fold sail,
And mounted up and glided down the billow
In happy freedom, pleased to feel the air,
And wander in the luxury of light.

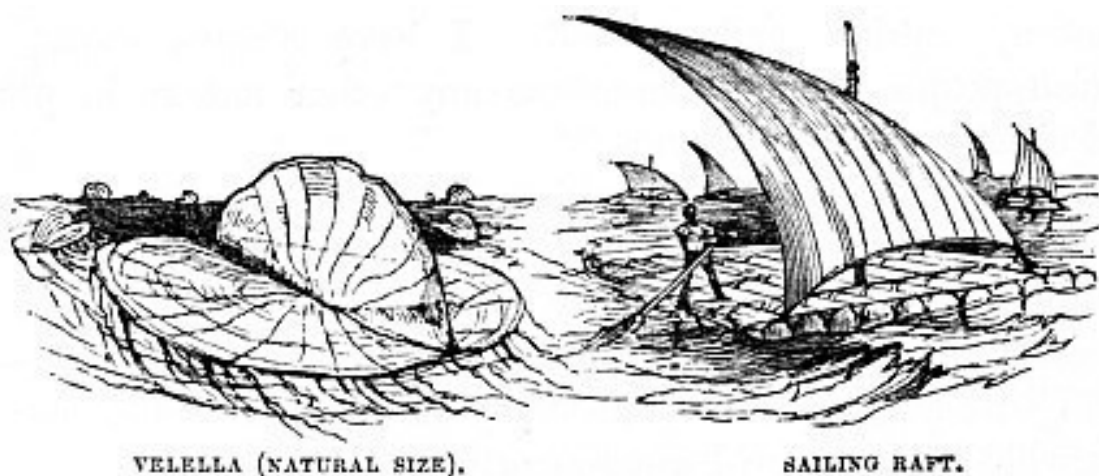
* * * * *

It closed, sank, dwindled to a point, then nothing,
While the last bubble crowned the dimpling eddy
Through which mine eye still giddily pursued it."

So deeply ingrained is the poetical notion of the sailing powers attributed to the nautilus, that many people are quite incredulous when they are told that there is just as much likelihood of seeing a mermaid curl her hair as of witnessing a nautilus under sail. How the creature in question does propel itself will be described in the course of the present chapter; and the reader will see that although one parallel between Nature and Art in the nautilus does not exist, there are several others which until later days have not even been suspected.

It is, therefore, partially true that science does destroy romance. But, though she destroys, she creates, and she gives infinitely more than she takes away, as is shown in the many late discoveries which have transformed the whole system of civilised life. Sometimes, as in the present instance, she discovers one analogy while destroying another, and though she shatters the legend of the sailing nautilus, she produces a marine animal which really does sail, and does not appear to be able to do anything else. This is the *Velella*, a figure of which, taken from a specimen in my collection, is given in the illustration, and drawn of the natural size.

It is one of that vast army of marine creatures known familiarly by the name of "jelly-fishes," just as lobsters, crabs, shrimps, oysters, whelks, periwinkles, and the like, are lumped together under the title of "shell-fish." As a rule, these creatures are soft, gelatinous, and, in fact, are very little more than sea-water entangled in the finest imaginable mesh-work of animal matter; so fine, indeed, that scarcely any definite organs can be discovered. The *Velella*, however, is remarkable for having a sort of skeleton, if it may be so called, consisting of two very thin and horny plates, disposed, as shown in the illustration, so as to form an exact imitation (or perhaps I should say a precursor) of a raft propelled by a sail. Indeed, the Latin name *Velella* signifies a little sail.



How well deserved is the name may be seen by the following graphic account of a *Velella* fleet sent to me by a lady who takes great interest in practical zoology:—

“The specimens which I send came from Tenby, a very rough sea having driven a large living fleet of them on that coast.

“When in life, they are semi-transparent, and radiant in many rainbow-tinted colours. They came floating towards me in all their fragile beauty on the rough sea waves. I succeeded in capturing some of them, and preserved the only portion available for my collection.

“They are extremely tender, and by no means with which I am acquainted can be preserved more than these skeleton-like cartilaginous plates. They soon dissolve in either spirits of wine or water, and lose every vestige of their shape and substance. The upright, thin, pellucid plate has the appearance of a fairy-like miniature sail, and apparently acted as such when the creature was floating with its long and many-tinted tentacles pendent from its lower surface.

“Although widely distributed, they are seldom seen on our own coast, although sometimes driven there from the warmer regions by stress of wind and waves.

“These little creatures had never before been seen at Tenby, but when I asked a native bathing-woman whether she knew their name, she immediately replied, ‘Sea-butterflies.’ Although the name was evidently of her own invention, it was most appropriate and poetical. I have always found the Welsh people abound more than any other nation in pretty and characteristic synonyms.”¹

In answer to a letter in which I asked the writer for some further information concerning the Velella, sending also an outline sketch of the animal, which I asked the writer to fill in with the proper colours, I received the following reply:—

“I will do my best to answer your questions, and to give you what information I can concerning the creatures.

“When seen at Tenby, they were all floating on the surface of the sea, the tentacles only being submerged. My specimens floated for a very short time after capture, death following so quickly that I was obliged to set to work at once with camel’s-hair brush and penknife to take away the gelatinous part. Indeed, decomposition took place so rapidly, that Velellas and myself were simultaneously threatened with extermination.

“Both raft and sail were equally enveloped in a soft, gelatinous covering, certainly not more than the sixteenth of an inch in thickness, except under the centre of the raft, where it became slightly thicker. The covering of the sail was exceedingly thin, and like a transparent and almost invisible soft skin. The sail is very firmly attached to the raft, as they did not separate when decomposition began.

“The tentacles were entirely composed of the same soft, jelly-like substance as that of the envelope, and every part was iridescent in a sort of vapoury transparent cloud of many-tinted colours, blue and pale crimson predominating. I have filled up to the best of my memory the little sketch, and only wish you could have seen the Velellas as I did, in their full life and beauty.”

Two of the specimens here mentioned are in my collection, and beautiful little things they are. The two plates are not thicker than ordinary silver paper, but are wonderfully strong, tough, and elastic. The oval horizontal plate, or raft, if it may be so called, is strengthened by being corrugated in concentric lines, and having a multitude of very fine ribs radiating from the centre to the circumference. It is slightly thickened on the edges, evidently for the attachment of the tentacles.

The perpendicular plate, or sail, does not occupy the larger diameter of the raft, but stretches across it diagonally from edge to edge, rising highest in the centre and diminishing towards the edges, so that it presents an outline singularly like that of a lateen sail. It is rather curious that the magnifying glass gives but little, if any, assistance to the observer, the naked eye answering every purpose. Even the microscope is useless, detecting no peculiarity of structure. I tried it with the polariscope, scarcely expecting, but rather hoping, to find that it was sensitive to polarised light. But no such result took place, the Velella being quite unaffected by it.

¹ By sailors the Velella is popularly known by the name of “Sally-man;” i.e. Sallee-man.

The corresponding illustration is a sketch of a raft to which a sail is attached. Such rafts as this are in use in many parts of the world, the sail saving manual labour, and the large steering oar answering the double purpose of keel and rudder. In the *Velella*, the tentacles, though they may not act in the latter capacity, certainly do act in that of the former, and serve to prevent the little creature from being capsized in a gale of wind.

The Boat

There is no doubt that the first idea of locomotion in the water, independently of swimming, was the raft; nor is it difficult to trace the gradual development of the raft into a Boat. The development of the Kruman's canoe into the *Great Eastern*, or a modern ironclad vessel, is simply a matter of time.

It is tolerably evident that the first raft was nothing more than a tree-trunk. Finding that the single trunk was apt to turn over with the weight of the occupant, the next move was evidently to lash two trunks side by side.

Next would come the great advance of putting the trunks at some distance apart, and connecting them with cross-bars. This plan would obviate even the chance of the upsetting of the raft, and it still survives in that curious mixture of the raft and canoe, the outrigger boat of the Polynesians, which no gale of wind can upset. It may be torn to pieces by the storm, but nothing can capsize it as long as it holds together.

Laying a number of smaller logs or branches upon the bars which connect the larger logs is an evident mode of forming a continuous platform, and thus the raft is completed. It would not be long before the superior buoyancy of a hollow over a solid log would be discovered, and so, when the savage could not find a log ready hollowed to his hand, he would hollow one for himself, mostly using fire in lieu of tools. The progress from a hollowed log, or "dug-out," as it is popularly called, to the bark canoe, and then the built boat, naturally followed, the boats increasing in size until they were developed into ships.

Such, then, is a slight sketch of the gradual construction of the Boat, based, though perhaps ignorantly, on the theory of displacement. Now, let us ask ourselves whether, in creation, there are any natural boats which existed before man came upon the earth, and from which he might have taken the idea if he had been able to reason on the subject. The Paper Nautilus is, of course, the first example that comes before the mind; but although, as we have seen, the delicate shell of the nautilus is not used as a boat, and its sailing and rowing powers are alike fabulous, there is, as is the case with most fables, a substratum of truth, and there are aquatic molluscs which form themselves into boats, although they do not propel themselves with sails or oars.

Many species of molluscs possess this art, but we will select one as an example of them all, because it is very plentiful in our own country, and may be found in almost any number. It is the common Water-snail (*Limnæa stagnalis*), which abounds in our streams where the current is not very strong. Even in tolerably swift streams the *Limnæa* may be found plentifully in any bay or sudden curve where a reverse current is generated, and therefore the force of the stream is partially neutralised. These molluscs absolutely swarm in the Cherwell, and in the multitudinous ditches which drain the flat country about Oxford into that river as well as the Isis.

Belonging to the Gasteropods, the Water-snail can crawl over the stones or aquatic vegetation, just as the common garden snail or slug does on land. But it has another mode of progression, which it very often employs in warm weather. It ascends to the surface of the water, reverses its position so that the shell is downward, spreads out the foot as widely as possible, and then contracts it in the centre, so as to form it into a shallow boat.



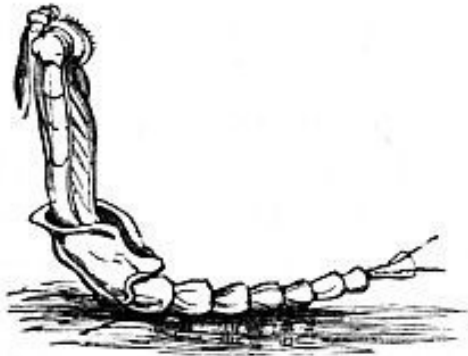
GNAT-EGG BOAT AND THREE EGGS.



SEA-ANEMONE ACTING AS BOAT.



WATER-SNAIL ACTING AS BOAT.



PUPA SKIN OF GNAT ACTING AS BOAT.



"DUG-OUT" BOAT OF VARIOUS PARTS OF THE WORLD.



BIRCH-BARK CANOE.

The carrying capacity of this boat is necessarily small, but as the shell and nearly the whole of the animal are submerged, and therefore mostly sustained by the water, a very small amount of flotative power is sufficient for the purpose. Sometimes, on a fine day, whole fleets of these natural boats may be seen floating down the stream, thus obtaining a change of locality without any personal exertion.

In perfectly still water, where no current can waft the *Limnæa* on its easy voyage, it still is able to convey itself from one place to another. By means of extending and contracting the foot, it actually contrives to crawl along the surface of the water almost as readily as if it were upon the under side of some solid body, and, although its progress is slow, it is very steady. Another very common British water-snail, the Pouch-shell (*Physa fontinalis*), has almost exactly the same habits. Reference will be made to the Pouch-shell on another page.

The capacity for converting the body into a boat is not confined to the molluscs, but is shared by many other animals. Take, for example, the well-known marine animals, called popularly Sea-anemones. As they appear when planted on the rocks, they look as incapable of motion as the flowers whose names they bear. Yet, by means of the flattened base, which they use just as a snail uses its feet, they can manage to glide along the rocks in any direction, though very slowly.

The base is capable of extension and contraction, and by elongating one side of it, fixing the elongated portion, and then raising the remainder of the base towards it, the animal makes practically

a series of very slow steps. This mode of progression may often be seen in operation on the glass front of an aquarium.

The same property of expansion and contraction enables the Sea-anemones to convert their bodies into boats, and float on the surface of the water. When one of these animals wishes to swim, it ascends the object to which it is clinging—say the glass of the aquarium—until it has reached the air. It then very slowly, and bit by bit, detaches the upper part of the base from the glass, allowing itself to hang with its tentacles downward. These, by the way, are almost wholly withdrawn when the animal is engaged in this business. By degrees the whole of the base is detached from the glass except a very tiny portion of the edge. The base is next contracted in the middle into the form of a shallow cup, and, when this is done, the last hold of the glass is released, and the animal floats away, supported by its hollowed base.

Entomologists are familiar with the following facts, and were this work addressed to them alone, a simple mention of the insect would be sufficient. But as this work is intended for the general public, it will be necessary to give a description, though a brief one, of the wonderful manner in which an insect, which we are apt to think is only too common, plays the part of a boat at its entrance to life and just before its departure from this world, not to mention its intermediate state, to which reference will be made under another heading.

The insect in question is the common Gnat (*Culex pipiens*), which makes such ravages upon those who are afflicted, like myself, with delicate skins, and can have a limb rendered useless for days by a single gnat-bite.

In this insect, the beginning and the end of life are so closely interwoven, that it is not easy to determine which has the prior claim to description, but we will begin with the egg.

With very few exceptions, such as the Earwig, which watches over its eggs and young like a hen over her nest and chickens, the insects merely deposit their eggs upon or close to the food of the future young, and leave them to their fate. The eggs of the Gnat, however, require different treatment. The young larvæ, when hatched, immediately pass into the water in which they have to live, and yet the eggs are so constituted that they need the warmth of the sun in order to hatch them. The machinery by which both these objects are attained is singularly beautiful.

The shape of the egg very much resembles that of a common ninepin, and the structure is such that it must be kept upright, so that the top shall be exposed to the air and sun, and the bottom be immersed in the water. It would be almost impossible that these conditions should be attained if the eggs were either dropped separately into the water or fixed to aquatic plants, as is the case with many creatures whose eggs are hatched solely in or on the water.

As is the case with many insects, each egg when laid is enveloped with a slight coating of a glutinous character, so that they adhere together. And, in the case of the Gnat, this material is insoluble in water, and hardens almost immediately after the egg is deposited. Taking advantage of these peculiarities, the female Gnat places herself on the edge of a floating leaf or similar object, so that her long and slender hind-legs rest on the water. In some mysterious way, the eggs, as they are successively produced, are passed along the hind-legs, and are arranged side by side in such a manner that they are formed into the figure of a boat, being fixed to each other by the glutinous substance which has already been mentioned.

It is a very remarkable fact, which assists in strengthening the theory on which this book is written, that the lines of the best modern life-boats are almost identical with those of the Gnat-boat, and that both possess the power of righting themselves if capsized. In all trials of a new life-boat, one of the most important is that which tests her capability of self-righting; and any one who has witnessed such experiments, and has tried to upset a Gnat-boat, cannot but be struck with the singular similitude between the boat made by the hand of man and that constructed by the legs of an insect, without even the aid of eyes.

Push the Gnat-boat under water, and it shoots to the surface like a cork, righting itself as it rises. Pour water on it, and exactly the same result occurs, so that nothing can prevent it from floating. Then, when the warm air has done its work in hatching the enclosed young, a little trap-door opens at the bottom of the egg, lets the young larvæ into the water, and away they swim.

Now we come to another phase of existence in which the Gnat forms a boat. Every one knows the little active Gnat larvæ, with their large heads and slender bodies, much like tadpoles in miniature. When they have reached their full growth, and assume the pupal form, their shape is much changed. The fore part of the body is still more enlarged, as it has to contain the wings and legs, which have so great a proportion to the body of the perfect Gnat. And, instead of floating with its head downwards, and breathing through its tail as it did when a larva, it now floats with the head uppermost, and breathes through two little tubes.

Even in its former state the creature had something almost grotesque in its aspect, the head, when magnified, looking almost as like a human face as does that of a skate. But in its pupal state it looks as if it had put on a large comical mask much too large for it, very much like those paper masks which are enclosed in crackers, and have to be worn by those who draw them.

In process of time the pupa changes to a perfect Gnat within this shelly case, able to move, but unable to eat. The body shrinks in size, and the wings and legs are formed, both being pressed closely to the body. When the Gnat is fully developed, the pupal skin splits along the back, and opens out into a curiously boat-like shape, the front, which contains the heavier part of the insect, being much the largest, and consequently being able to bear the greatest weight.

By degrees, the Gnat draws itself out of the split pupal skin, resting its legs on it as fast as they are released. It then shakes out its wings to dry, and finally takes to the air.

It is a really wonderful fact that the insect which, for three stages in life—namely, an egg, larva, and pupa—lived in the water, should in the fourth not only be incapable of aquatic life, but should employ its old skin to protect it from that very element in which it was living only a minute or two before.

Should the reader wish to examine for himself either the egg or skin boat of the Gnat, he can easily procure them by searching any quiet pond, or even an uncovered water-butt. They are, of course, very small, averaging about the tenth of an inch in length, and are nearly always to be found close to the side either of pond or tub, being drawn there by the power of attraction.

I may here mention that there are other dipterous insects belonging to the genus *Stratiomys*, which undergo their metamorphosis in a very similar fashion. In these insects, the larva breathes through the tail, and when it attains its pupal condition, the actual insect is very much smaller than the pupal skin, only occupying the anterior and enlarged part. Indeed, the difference of size is so great, that several entomologists believed the future *Stratiomys* to be but a parasite on the original larva. The beautiful Chameleon-fly (*Stratiomys chamaeleon*) is a familiar example of these insects.

CHAPTER II.

THE OAR, THE PADDLE, AND THE SCREW

Propulsion by the Oar.—Parallels in the Insect World.—The “Water-boatman.”—Its Boat-like Shape.—The Oar-like Legs.—Exact mechanical Analogy between the Legs of the Insect and the Oars of the human Rower.—“Feathering” Oars in Nature and Art.—The Water-boatman and the Water-beetles.—The Feet of the Swan, Goose, and other aquatic Birds.—The Cydippe, or Beroë.—The Self-feathering Paddle-wheel.—Indirect Force.—The Wedge, Screw, and Inclined Plane.—“Sculling” a Boat.—The “Tanka” Girls of China.—Mechanical Principle of the Screw, and its Adaptation to Vessels.—Gradual Development of the Nautical Screw.—Mechanical Principle of the Tail of the Fish, the Otter, and the sinuous Body of the Eel and Lampyris.—The Coracle and the Whirlwig-beetle.

THE Boat naturally reminds us of the Boatman. In the two gnat-boats which have been described there is no propelling power used or needed, the little vessel floating about at random, and its only object being to keep afloat. But there are many cases where the propelling power is absolutely essential, and where its absence would mean death, as much as it would to a ship which was becalmed in mid ocean without any means of progress or escape. There are, for example, hundreds of creatures, belonging to every order of animals, which are absolutely dependent for their very existence on their power of propulsion, and I believe that there is not a single mode of aquatic progression employed by man which has not been previously carried out in the animal world. There are so many examples of this fact that I am obliged to select a very few typical instances in proof of the assertion.

Taking the Oar as the natural type of progression in the water, we have in the insect world numerous examples of the very same principle on which our modern boats are propelled. And it is worthy of notice, that the greater the improvement in rowing, the nearer do we approach the original insect model.

The first which we shall notice is the insect which, from its singular resemblance to a boat propelled by a pair of oars, has received the popular name of Water-boatman. Its scientific name is *Notonecta glauca*, the meaning of which we shall presently see. It belongs to the order of Heteroptera, and is one of a numerous group, all bearing some resemblance to each other in form, and being almost identical in habits. Though they can fly well, and walk tolerably, they pass the greater part of their existence in the water, in which element they find their food.

Predacious to a high degree, and armed with powerful weapons of offence, it is one of the pirates of the fresh water, and may be found in almost every pond and stream, plying its deadly vocation.

Its large and powerful wings seem only to be employed in carrying it from one piece of water to another, while its first and second pairs of legs are hardly ever used at all for progression. The last pair of legs are of very great length, and furnished at their tips with a curiously constructed fringe of stiff hairs. The body is shaped in a manner that greatly resembles a boat turned upside down, the edge of the elytra forming a sort of ridge very much like the keel of the boat.

When the creature is engaged in swimming, it turns itself on its back, so as to bring the keel downwards, and to be able to cut the water with the sharp edge. From this habit it has derived the name of *Notonecta*, which signifies an animal which swims on its back. The first and second pairs of legs are clasped to the body, and the last pair are stretched out as shown in the illustration, not only looking like oars, but being actually used as oars.

Now, I wish especially to call the reader's attention to the curiously exact parallel between the water-boatman and the human oarsman. As the reader may probably know, the oar is a lever of the

second order, *i.e.* the power comes first, then the weight, and then the fulcrum. The arm of the rower furnishes the power, the boat is the weight to be moved, and the water is the fulcrum against which the lever acts.

I have more than once heard objections to this definition, the objectors saying that the water was a yielding substance, and therefore could not be the fulcrum. This objection, however, was easily refuted by taking a boat up a narrow creek, and rowing with the oar-blades resting on the shore, and not in the water.



Now, the swimming legs of the water-boatman are exact analogues of the oars of a human rower. The internal muscles at the juncture of the leg with the body supply the place of the rower's arms, the leg itself takes the office of the oar, and the body of the insect is the weight to be moved, and the water supplies the fulcrum. Even the broad blade at the end of the oar is anticipated by the fringe of bristles at the end of the leg, and its sharpened edge by the shape of the insect's limb.

Besides these resemblances, there is another which is worthy of notice. All rowers know that one of their first lessons is to "feather" their oars, *i.e.* to turn the blade edgewise as soon as it leaves the water. Nothing looks more awkward than for a boatman to row without feathering. (We all must remember the eulogy on the "Jolly Young Waterman," who "feathered his oars with skill and dexterity.") In the first place, he must lift his oar very high out of the water, and, in the second, he will be impeded by any wind that happens to come against the blades.

The Water-boatman, however, does not lift its legs out of the water after every stroke, as a human boatman does, and therefore it has no need to feather in the same way. But there is even greater need for a feathering of some kind in the insect's leg, on account of the greater resistance offered by water than by air, and this feathering is effected by the arrangement of the blade-bristles, which spread themselves against the water as the stroke is made, and collapse afterwards, so as to give as little resistance as possible when the stroke is completed.

In Art we have invented many similar contrivances, but I believe that there is not one in which we have not been anticipated by Nature. Putting aside the insect which has just been described, we have the whole tribe of water-beetles, in which the same principle is carried out in an almost identical manner. In the accompanying illustration, the oar, the rower, and the boat are placed above one another, and next to them are seen one of the oar-legs of the water-boatman and the insect as it appears when swimming on its back.

Then, there is the foot of the duck, goose, swan, and various other aquatic birds, in which the foot presents a broad blade as it strikes against the water, and a narrow edge as it recovers from the stroke. Some years ago, a steam yacht was built and propelled by feet made on the model of those of the swan. She was a very pretty vessel, but art could not equal nature, and at present the swan-foot

propeller, however perfect in theory, has not succeeded in action. Perhaps, if some nautical engineer were to take it in hand, he would procure the desired result.

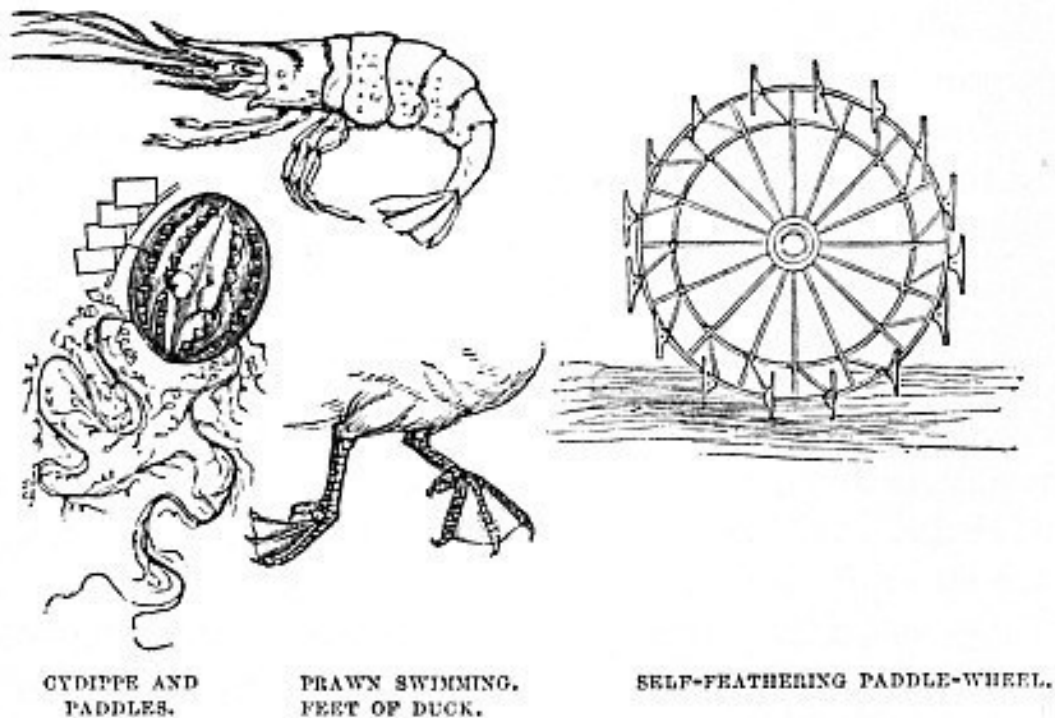
Almost exactly similar is the mode of propulsion employed by the lobster, the prawns and shrimps, their tails expanding widely into a fan-like shape as they strike against the water, and then collapsing when the stroke is withdrawn, so as to allow them to pass through the water with the least possible resistance.

The same principle is to be seen in the lively little Acaleph, for which there is unfortunately no popular name, and which we must therefore call by its scientific title of Cydippe, or Beroë, these names being almost indifferently used. When full grown, it is about as large as an acorn, and very much of the same shape. It is as transparent as if made of glass, and, when in the water, is only visible to practised eyes.

En passant, I may remark that the familiar term of “water,” when applied to diamonds, is owing to their appearance when placed in distilled water. Those which can be at once seen are called stones of the second water. Those which cannot be seen, because their refractive powers are equal to those of the water, are called “diamonds of the first water,” and are very much more valuable than the others.

As the Cydippe is, in fact, little more than sea-water, entangled in the slightest imaginable and most transparent tissue of animal fibre, it is evident that the water and the Cydippe must be of almost equal refracting power, and that therefore the acaleph must be as invisible as diamonds of the “first water.” Indeed, I have often had specimens in a glass jar which were absolutely invisible to persons to whom I wished to show them.

But an experienced eye detects the creature at once. Along its body, at equal distances, are eight narrow bands, over which the colours of the rainbow are, though very faint, perpetually rippling. This appearance is caused by the machinery which impels the body, and which seems never to cease. Each of these bands is composed of a vast number of tiny flaps, which move up and down in regular succession, so as to cause the light to play on their surfaces. And, as they move as if set on hinges, they of course offer no resistance to the water after their stroke is made.



Now let us compare these works of nature with those of art. We have already seen the parallels of the oar, and we now come to those of the paddle-wheel. When paddle-steamers were first invented, the blades were fixed and projected from the wheel, as if they had been continuations of its spokes. It was found, however, that a great waste of power, together with much inconvenience, was caused by this arrangement. Not only was a considerable weight of water raised by each blade after it passed the middle of its stroke, but the steam power was given nearly as much to lifting and shaking the vessel as to propulsion.

A new kind of paddle-wheel was then invented, in which the blades were ingeniously jointed to the wheel, so that they presented their flat surfaces to the water while propelling, and their edges when the stroke was over. This, which is known by the name of the "Self-feathering Paddle-wheel," was thought to be a very clever invention, and so it was; but not even the inventors were likely to have known that if they had only looked into the book of Nature, they might have found plenty of self-feathering paddle-wheels, beside the few which my limited space enables me to give.

If the reader will look at the illustration, he will see that on one side is represented the self-feathering paddle-wheel of Art, with its ingenious arrangement of rods and hinges. On the other side there comes, first, the common Prawn, shown with its tail expanded in the middle of its stroke.

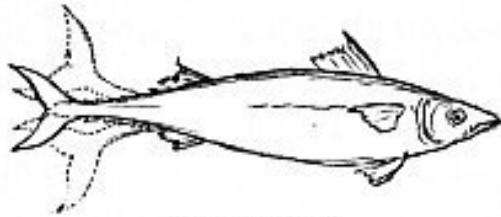
Just below it is a Cydippe of its ordinary size, showing the paddle-bands, one of which is drawn at the side much magnified, so as to show the arrangement of the little paddles. As to the tentacles which trail from the body, we shall treat of them when we come to our next division of the subject of the work.

Lastly, there is a representation of the self-feathering feet of the Duck, the left foot expanded in striking the water, and the right closed so as to offer no resistance when drawn forward for another stroke. The swan's foot shows this action even more beautifully than does that of the duck.

We now come to another mode of propulsion, namely, that which is not due to direct pressure of a more or less flat body against the water, but to the indirect principle of the screw, wedge, or inclined plane.

Space being valuable, I will only take two instances, namely, the well-known mode of propelling a boat by a single oar working in a groove or rowlock in the middle of the stern, and the ordinary screw of modern steamers.

Most of my readers must have seen a sailor in the act of "sculling" a boat. A tolerably deep notch is sunk in the centre of the stern, and the oar is laid in it, as shown in the central illustration, on the right-hand side. The sailor then takes the handle of the oar, and works it regularly backwards and forwards, without taking the blade out of the water. The boat at once begins to move forward, and, when the oar is urged by a strong and experienced man, can be propelled with wonderful speed. The well-known "Tanka" boat-girls of China never think of using two oars, a single oar in the stern being all-sufficient for the rapid and intricate evolutions required in their business.



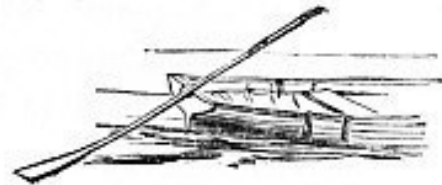
TAIL OF FISH.



SCREW OF STEAMER.



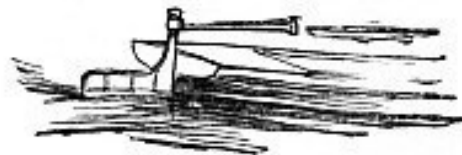
TAIL OF OTTER.



"SCULLING" A BOAT.



TAIL OF SEAL.



ACTION OF RUDDER.

The mechanical process which is here employed is nothing more than that of the inclined plane, or rather, the wedge, the oar-blade forming the wedge, and the force being directed against the stern of the boat, and so driving it through the water.

The Rudder affords another example of a similar force, although it is used more for directing than propelling a vessel. Still, just as the scull is used not only for propelling, but for steering the boat, the rudder, when moved steadily backwards and forwards, can be used for propulsion as well as steerage. In the absence of oars, this property is most useful, as I can practically testify.

So different in appearance are the screw and the inclined plane, that very few people would realise the fact that the screw is nothing but an inclined plane wound round a cylinder, or rather, is a circular inclined plane. The ordinary corkscrew is a good example of this principle, the cylinder being but an imaginary one.

Now, if the screw be turned round, it is evident that force is applied just on the principle of the wedge, and this principle is well shown in the various screw-presses, of which the common linen-press is a familiar example, as was the original printing-press, which still survives as a toy for children.

We all know the enormous force exerted by screws when working in wood, and how, when the screw-driver is turned in the reverse direction, the instrument is forced backwards, though the operator is leaning against it with all his weight. In fact, a comparatively small screw, if working in hard wood or metal, so that the threads could not break, could lift a heavy man.

Substitute water for wood or metal, and the result would be the same in principle, though the resistance would be less. As the loss of power by friction would prevent a large vessel from being propelled by a stern oar moved like a scull, the idea was invented of applying the same kind of power by a large screw, which should project into the water from the stern of the vessel. This modification, moreover, would have the advantage of forcing the vessel forward when the screw was turned from left to right, and drawing it back when turned in the opposite direction, whereas the sculling oar would only drive it forward.

The principle was right enough, but there was at first a great difficulty in carrying it out. Firstly, several turns of a large screw were used, and were found to need power inadequate to the effect. Then

the screw was reduced to four separate blades, and now only two are used, as shown in the illustration, these saving friction, being equally powerful for propulsion, and running less risk of fouling by rigging blown overboard or other floating substances.

So much for Art. Now for the same principle as shown in Nature, of which I can take but a very few instances.

The first and most obvious example is that of the Fish-tail, which any one may observe by watching ordinary gold fish in a bowl. Their progression is entirely accomplished by the movement of the tail from side to side, exactly like that of the sculling oar, and moreover, like the oar, the tail acts as rudder as well as propeller.

The force with which this instrument can be used may be estimated by any one who is an angler, and knows the lightning-like rush of a hooked trout, or who has seen the wonderful spring with which a salmon shoots clear out of the water, and leaps up a fall several feet in height. This is not done, as many writers state, by bending the body into a bow-like form, and then suddenly straightening it, but by the projectile force which is gained by moving the tail backwards and forwards as a sculler moves his oar.

Perhaps some of my readers have seen the wonderful speed, ease, and grace with which an Otter propels itself through the water. As the otter feeds on fish, and can capture even the salmon itself, its powers of locomotion must be very great indeed. And these are obtained entirely by means of the tail, which is long, thick, and muscular, and can be swept from side to side with enormous force, considering the size of the animal. The legs have little or nothing to do with the act of swimming. The fore-legs are pressed closely against the body, and the hind-legs against each other. The latter act occasionally as assistants in steering, but that is all.

Then there are the various Seals, whose hind-legs, flattened and pressed together, act exactly like the tail of the fish, that of the otter, the oar of the sculler, or the screw of the steamer. Also, the eel, when swimming, uses exactly the same means, its lithe body forming a succession of inclined planes; so does the snake, and so does the pretty little lampern, which is so common in several of our rivers, and so totally absent from others.

I can only now give a short description of the woodcut which illustrates these points.

On the right hand Art is shown by the screw-blades of the modern steamer. In the middle is the ordinary mode of sculling a boat by an oar in the stern, and below it is the rudder, which, like the sculling oar, may be used either for propulsion or direction.

On the left hand we have three examples of the same mechanical powers as shown in Nature. The uppermost figure represents a fish as in the act of swimming, the dotted lines showing the movement of its tail, and the principle of the wedge. In the middle is an otter, just preparing to enter the water, and below is a seal, both of them showing the identity of mechanism between themselves and the art of man. I need not say that the mechanism of art is only a feeble copy of that of nature, but nothing more could be expected.

While we are on this subject I may as well mention two more applications of the screw principle. The first is the windmill, the sails of which are constructed on exactly the same principle as the blades of the nautical screw. Only, as they are pressed by the wind, and the mill cannot move, they are forced to revolve by the pressure of the wind, just as the screw of a steamer revolves when the vessel is being towed, and the screw left at liberty.

Moreover, just as the modern screws have only two blades, so, many modern windmills have only two sails, the expense and friction being lessened, and the power not injured.

Again: some years ago there was a very fashionable toy called the aërial top. It was practically nothing but a windmill in miniature, rapidly turned by a string, after the manner of a humming-top. The edges of the sails being turned downwards, the instrument naturally screwed itself into the air to a height equivalent to the velocity of the motion.

A similar idea has been mooted with regard to the guidance of balloons, or even to aërial voyaging without the assistance of gas, but at present the weight of the needful machinery has proved to be in excess of the required lifting power.

In fine, the application of the inclined plane, wedge, or screw as a motive power, is so wide a subject that I must, with much reluctance, close it with these few and obvious examples.

It is worth while, by the way, to remark how curiously similar are such parallels. I have already mentioned the very evident resemblance between the water-boatman, the water-beetles, and the human rower, the body of the insect being shaped very much like the form of the modern boat. I must now draw the attention of the reader to the similitude between the very primitive boat known by the name of Coracle, and the common Whirlwig-beetle (*Gyrinus natator*), which may be found in nearly every puddle. The shape of the insect is almost identical with that of the boat, and the paddle of the coracle is an almost exact imitation of the swimming legs of the whirlwig. And, as if to make the resemblance closer, many coraclers, instead of using a single paddle with two broad ends, employ two short paddles, shaped very much like battledores.



WHIRLWIG BEETLE AND PADDLES.



CORACLE AND PADDLE.

CHAPTER III. SUBSIDIARY APPLIANCES.—Part I

General Sketch of the Subject.—The Mast of Wood and Iron.—Analogy between the Iron Mast and the Porcupine Quill.—The Iron Yard and its Shape prefigured by the same Quill.—Beams of the Steam-engine.—Principle of the Hollow Tube in place of the Solid Bar.—Quills and Bones of Birds.—Wheat Straws and Bamboos.—Structure of the Boat.—The Coracle, the Esquimaux Boat, and the Bark Canoe.—Framework of the Ship and Skeleton of the Fish.—Compartments of Iron Ship and Skull of Elephant.—The Rush, the Cane, and the Sugar-cane.—“Stellate” Tissue and its Varieties.

HAVING now treated of the raft, the boat, the ship, and their various modes of propulsion and guidance, we come to the subsidiary appliances to navigation, if they may be so called in lack of a better name.

First in importance is necessarily the mast; and the yards, which support the sails, are naturally the next in order. Then there come the various improvements in the building of vessels; namely, the substitution of planks fastened on a skeleton of beams for a mere hollowed log, and the subsequent invention of iron vessels with their numerous compartments, giving enormous strength and size, with very great comparative lightness.

Then we come to the various developments of the ropes or cables, by which a vessel is kept in its place when within reach of ground, whether on shore or at the water-bed. Next come the different forms of anchors which fasten a vessel to the bed of the ocean, of grapnels by which she can be made fast to the shore, or of “drags,” which at a pinch can perform either office, and can besides be utilised in searching for and hauling up objects that are lying at the bottom of the sea.

Next we come to the boat-hook, which is so useful either as a temporary anchor, or as a pole by which a boat can be propelled by pushing it against the shore or the bed of the water; and then to the “punt-pole,” which is only used for the latter purpose.

Lastly, we come to the life-belt and life-raft, which are now occupying, and rightly, so much of the public attention. These subjects will be treated in their order in the present chapter, and I hope to be able to show the reader that in all these points nature has anticipated art.

I presume that most, if not all, of my readers are aware of the rapidly extending use of iron in ship-building, not only in the standing rigging, but in the material of the vessel. First there came iron “knees,” *i.e.* the angular pieces of wood which strengthen the junctions of the timbers. Formerly these were made of oak-branches, and, as it was not easy to find a bough which was naturally bent at such an angle as was required for a “knee,” such branches were exceedingly valuable. Iron, however, was then employed, and with the best results. It was lighter than the wooden knee, was stronger, could be bent at any angle, and took up much less space.

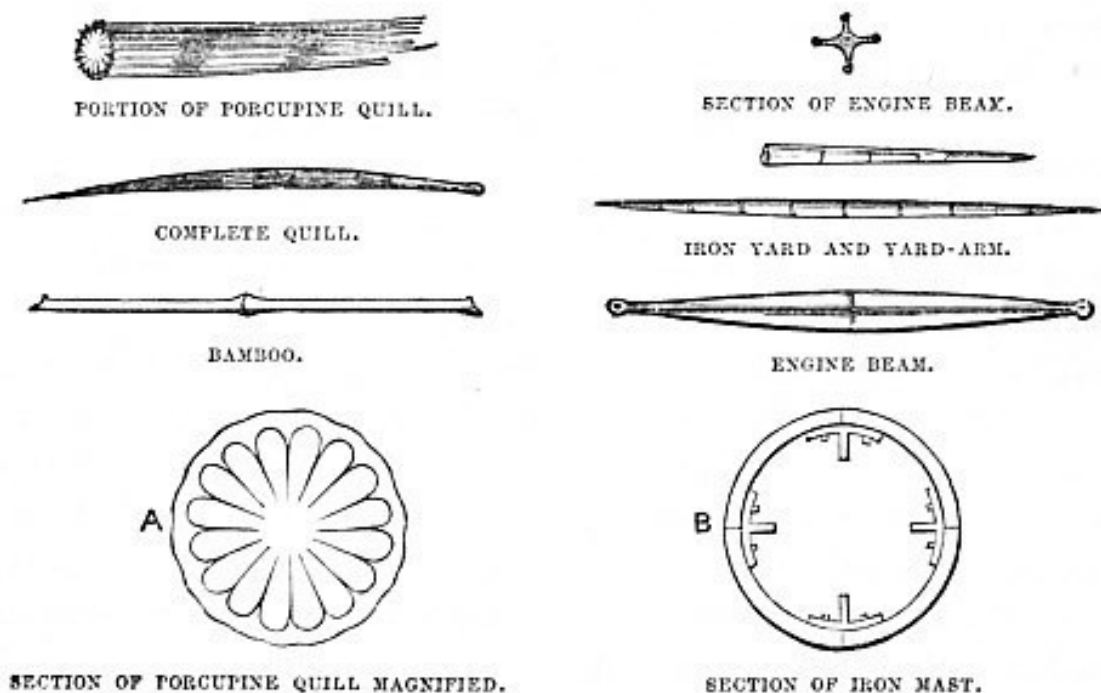
By degrees iron was used more and more, until vessels were wholly made of that material. Then the masts, and even the yards, were made of iron, and, strange as it may appear, were found to be lighter as well as stronger than those made of wood. Of course, the masts and yards were hollow, and it was found by the engineers that in order to combine lightness with great strength, the best plan was to run longitudinal ridges along the inside of the tube.

A section of one of these masts is given at Fig. B, and taken from the drawings of one of our largest engineering firms. The reader will see that the mast is composed of rather slight material, and that it is strengthened by four deep though thin ribs, which run throughout its length.

When I first saw this mast I was at once struck with the remarkable resemblance between it and the quill of the Porcupine. These quills, as all anglers know, are very light, and of extraordinary

strength when compared with their weight. Indeed, they are so light that they are invaluable as penholders to those who are obliged to make much use of their pen. I have used nothing else for a very long time, and the drawing of the Porcupine quill which is here given at Fig. A was made from a small piece cut from the top of the penholder which I have used for some fifteen years, and with which all my largest and most important works were written, including the large “Natural History,” “Homes without Hands,” “Man and Beast,” &c., &c. A portion of the same quill is also shown of its real size.

If the reader will cut a Porcupine quill at right angles, make a thin section of it, and place it under the microscope, or even under an ordinary pocket lens, he will see that the exterior is composed of a very thin layer of horny matter, and the interior filled with a vast number of tiny cells, which are formed much on the same plan as the pith of elder and other plants. The analogies of the pith will be treated in another page.



But were the quill merely a hollow tube filled with pith, it would be too weak to resist the strain to which it is often liable. Consequently it is strengthened by a number of internal ribs, composed of the same horny material as the outer coat, and arranged in exactly the same way as those of the mast.

There are yet other points in the structure of the Porcupine quill which might be imitated with advantage in the mast. In the first place, the internal ribs are much more numerous than those of the mast, but they are very much thinner, and taper away from the base, where the greatest strain exists, to the end, where they come to the finest imaginable edge. This modification of structure enables the outer shell of the quill to be exceedingly thin and light, and, moreover, gives to the whole quill an elasticity which is quite wonderful, considering its weight and strength.

Then, in the iron mast the exterior is quite smooth, whereas in the Porcupine quill it is regularly indented, exactly on the principle of the corrugated iron, which combines great strength with great lightness. And I cannot but think that our iron masts might be made both lighter and stronger if the shell were thinner, the internal ribs made like those of the Porcupine quill, and the shell corrugated instead of being quite smooth. The internal cells of the quill are, of course, not needed in the mast, as they are intended for nutrition, and not for strength.

Being on this subject, we may take the shape of the Porcupine quill, and compare it with that of the ship's yard. It will be seen that the two are so exactly similar in form that the outline of one would answer perfectly well for the other. The only perceptible difference is, that in the ship's yard both ends are alike, whereas in the Porcupine quill the end which is inserted in the skin is rounded and slightly bent, while the other end is sharply pointed.

The principal point to be noticed in the form of both quill and yard is, that they become thicker in the centre, that being the spot on which the greatest strain comes, and which, in consequence, needs to be stronger than any other part. While holding and balancing the pole which Blondin uses to preserve his balance when walking on the high rope, I was struck with the fact that the pole, which is heavily weighted at each end, had to be strengthened in the middle, exactly on the principle of the Porcupine quill and the ship's yard. It could not, of course, be thickened, as the hands could not grasp it, but it had to be furnished with additional strengthening. And the necessity of such strengthening is evident from the fact that on one occasion the pole did break in the middle, so that any one of less nerve and presence of mind must have been killed.

Bearing in mind, then, that in a rod or pole the centre is the part which most requires to be strengthened, we can see, in cases too numerous to mention, how art has followed, though perhaps unconsciously, in the footsteps of nature. Take, for example, the beam of a steam-engine, such as is given in the sketch, and for which the great engine at Chatham acted as model. The reader will observe that in this case the beam is gradually thickened towards the centre, the ends, where the strain is slightest, being comparatively small.

Another point also must be noticed. Equal strength could have been obtained had the beam been solid, but at the expense of weight, and consequent waste of power. Lightness is therefore combined with strength by making the beam consist of a comparatively slight centre, but having four bold ridges, as shown in the section given in the accompanying illustration. This plan, as the reader will see, is exactly the same as that which is adopted in the iron mast and porcupine quill, except that the ridges are external instead of internal. The same mode of construction is employed in ordinary cranes, the principal beam of which is almost identical in form with that of the engine, both being thickest in the centre, and both strengthened with external ridges.

There are also other analogies between the hollow mast and natural objects. Keeping still to the animal world, we find the quill feathers of the flying birds to supply examples of the combination of great strength with great lightness and very little expenditure of material. Their wing bones, too, are hollow, communicating with the lungs, and are consequently light as well as strong.

Passing to the vegetable world, we find a familiar example of this structure in the common Wheat Straw. The ripe ear is so heavy, when compared with the amount of material which can be spared to carry it, that if the stalk were solid it would give way under the mere weight of the ear. Moreover, the full-grown corn has to endure much additional weight when wetted with rain, and to resist much additional force when bowed by the wind, so that a slight and solid stalk would be quite inadequate to the task of supporting the ear.

The material of the stalk is therefore utilised in a different manner, being formed into a hollow cylinder, the exterior of which is coated with a very thin shell of flint, or "silex" as it is scientifically termed. The result of this structure is that the stem possesses strength, lightness, and elasticity, so as to be equal to the burden which is laid upon it.

Then there is the common Bamboo, which is little more than a magnified straw, being constructed in much the same manner, and possessing almost the same constituents of vegetable matter and silex.

Perhaps the most extraordinary of the tubal system is to be found in the remarkable plant of Guiana called by the natives Ourah, and scientifically known by the name of *Arundinaria Schomburgkii*. Like the bamboo, it grows in clusters, and has a feathery top, which waves about in the breeze. But, instead of decreasing gradually in size from the base upwards, the Ourah, although

it runs to some fifty feet in height, is nowhere more than half an inch in diameter. The first joint is about sixteen feet in length, and uniform in diameter throughout.

It is scarcely thicker than ordinary pasteboard, and yet so strong and elastic is it, that it can sustain with ease the weight and strain of its feathery top as it blows about in the breeze. The natives of certain parts of Guiana use this reed as a blow-gun, and I have a specimen, presented to me by the late Mr. Waterton, which is eleven feet in length.

So the reader will see that when engineers found that hollow iron beams were not only lighter, but stronger than solid beams, they were simply copying the hollow beams formed by Nature thousands of years ago.

Another great improvement in ship-building now comes before us.

We have already seen that the earliest boats were merely hollowed logs, just as Robinson Crusoe is represented to have made. But these had many disadvantages. They were always too heavy. They were liable to split, on account of flaws in the wood, and if a large vessel were needed, it was difficult to find a tree sufficiently large, or to get it down to the water when finished.

So the next idea was to build a skeleton, so to speak, of light wooden beams, and to surround it with an outer clothing, or skin, if it may be so termed. As far as I know, the two original types of this structure are the Coracle of the ancient Briton, and the birch-bark Canoe of the North American Indian, and it is not a little remarkable that both exist to the present day, with scarcely any modification.

The Coracle has been already represented on page [22](#). It is, perhaps, or was in its original form, the simplest boat in existence, next to the “dug-out.” In the times of the very ancient Britons, who were content with blue paint by way of dress, and lived by hunting and fishing, the Coracle was a basin-shaped basket of wicker-work, rather longer than wide, and covered with the skin of a wild ox. This was sufficiently light to be carried by one man, and sufficiently buoyant to bear him down rapids, if he were a skilful paddler, and, of course, formed a considerable step in civilisation.

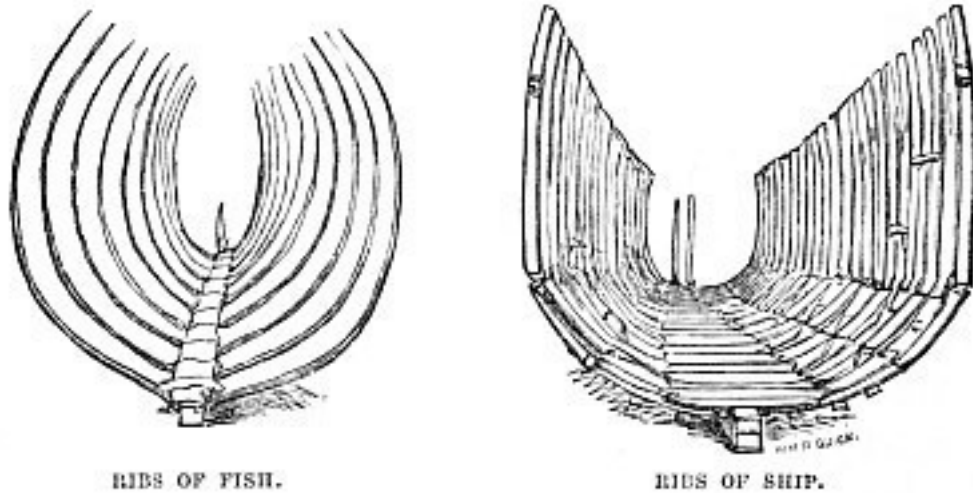
The modern Coracle is identical in form, and almost in material. The frame is still oval and basin-shaped, and made of wicker, but the outer covering is not the same. An ox-hide is an expensive article in these days, and, especially when wetted, is very heavy. So the modern Coracle builder covers the wicker skin with a piece of tarpaulin, which is much cheaper than the ox-hide, much lighter, is equally water-tight, and has the great advantage of not absorbing moisture, so that it is as light after use as before.

The Esquimaux make a boat on very similar principles. It is simply hideous in form, resembling a huge washing tub in shape, but, as it is only intended for the inferior beings called women, this does not signify.

Best, most perfect, and most graceful of all such boats is the Birch-bark Canoe of the North American Indians, whose shape has evidently been borrowed from that of a fish. I have seen many of these canoes, and have now before me several models which are exactly like the originals, except in point of size. Instead of being mere elongated bowls, like the coracle, they are long and slender, swelling out considerably in the middle, and coming to an almost knife-like edge at each end. Both stem and stern are alike, so that the canoe can be paddled in either direction, and, as one of the paddlers always acts as steersman, no rudder is needed.

The mode of construction is perfectly simple. The labour is divided between the sexes: the women cut large sheets of bark from the birch-trees, scrape and smooth them, and then sew them together, so as to form the outer skin, or “cloak” as it is called, of the canoe. Meanwhile the men are making the skeleton of strips of white cedar-wood, and binding them into shape with thongs made of the inner bark of the same tree, just like the “bass” of our gardeners. The “cloak” is then gradually worked over the skeleton, sewn into its place, and the canoe is finished. A figure of this canoe, as completed, is given in the same illustration as that which represents various forms of boat, page 7.

The last improvement is that which was caused by the necessity for large vessels, when planks or iron plates were fastened over the skeleton. But, in all these cases, the vessel is built on the principle of the thorax of a vertebrate animal, that of the whale or a fish being an admirable example. It only needs to take the skeleton of a whale, turn it on its back, and the ribs will be seen to form an almost exact reproduction of those of any ship being built in the nearest dockyard.



I have now before me the spine and ribs of a herring. The fish was over-boiled, and the flesh fell off the bones as it was being lifted out of the dish, leaving most of the ribs in their places. When held with the spine downwards, and viewed from one end, the resemblance to the framework of a ship is absolutely startling, the ribs representing the beams, and the spine taking the place of the keel. I have also before me a sketch representing a section of a Fijian canoe, and it is remarkable that even the very curve of the ribs of the herring is reproduced in those of the canoe.

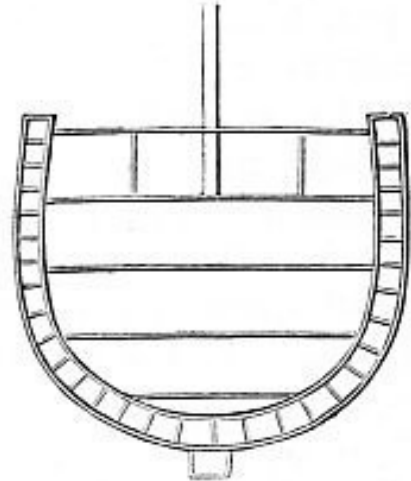
Whether the Fijians derived this peculiar and beautiful curve from the ribs of a fish I cannot say, but think it very likely.

A still greater improvement in ship-building now comes before us, and this also has been anticipated both in the animal and vegetable kingdoms. There are so many examples of this anticipation that I can only give one or two.

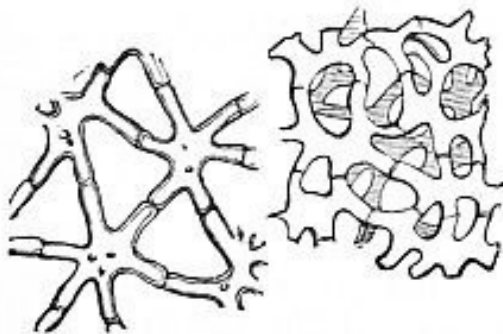
The improvement to which I refer is that which is now almost universally employed in the construction of iron ships, namely, the making the outer shell double instead of single, and dividing it into a number of separate compartments. Putting aside the advantage that if the vessel were stove, only one compartment would fill, we have the fact that the ship is at the same time enormously strengthened and very light in proportion to her bulk.



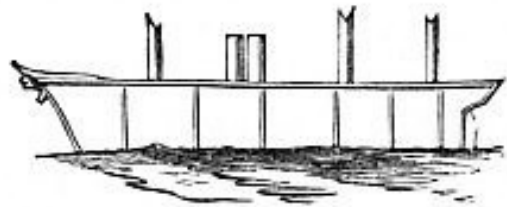
SECTION OF ELEPHANT SKULL.



TRANSVERSE SECTION OF IRON SHIP.



STELLATE TISSUES.



LONGITUDINAL SECTION OF IRON SHIP.

Perhaps the best, and certainly the most obvious, example of this principle in the animal world is to be found in the skull of the Elephant. The enormous tusks, with their powerful leverage, the massive teeth, and the large and weighty proboscis, require a corresponding supply of muscles, and consequently a large surface of bone for the attachments of these muscles. Now, were the skull solid in proportion to its requisite size, its weight would be too much for the neck to endure, however short and sturdy it might be. The mode of attaining expanse of surface, together with lightness of structure, is singularly beautiful.

Perhaps some of my readers may not be aware that the bone of the skull consists of an outer and inner plate, with a variable arrangement of cells between them. In many animals, such, for example, as man, where the jaws are comparatively feeble, and the teeth small and light, the size of the skull is practically that of the brain, to which it affords a covering. The same structure may be observed in the skull of the common sparrow, where, as in man, the two bony plates are set almost in contact.

But in the elephant these external and internal plates are set widely apart, and the space between them is filled with bony cells, much resembling those of a honeycomb. They are, in fact, just the same cells as those which exist in the skull of man and sparrow, but they are very much enlarged, and in consequence give a large surface, accompanied with united strength and lightness.

There are many other examples in the animal kingdom, but our limited space will not allow them to be even mentioned.

As to the vegetable examples of this principle, they are so multitudinous that only a very slight description can be given of them.

I suppose that most boys have seen a "cane" (whether they have felt it or not is not to the purpose), and some boys have made sham cigars from pieces of cane. In either case they must have

noticed that the cane is not solid, but is pierced with a vast number of holes, passing longitudinally through it, and is, in fact, a collection of little tubes connected and bound together by a common envelope.

The Sugar-cane, if cut across, is seen also to consist of multitudinous cells, which, however, are not hollow, but filled with the sweet liquid from which sugar is obtained by boiling. Then there are many of our common English plants, like the ordinary rush or reed, which are very slight in diameter in comparison with their length, and in which the cells are still further strengthened and lightened by the projection of their sides into a number of points which meet each other, and leave interstices between them. This modification of the cellular system is called “Stellate” (or star-like) Tissue, and two examples of it are given in the illustration, one being taken from the common rush, and the other from the seed-coat of the privet. A very good specimen of stellate tissue may be obtained by cutting a thin section of the white inner peel of the orange.

CHAPTER IV. SUBSIDIARY APPLIANCES.—Part II

The Cable and its Variations.—Material of Cables.—Hemp and Iron Cables, and Elasticity of the latter.—Natural Cables.—The “Byssus” of the Pinna and the common Mussel.—The Water-snail and its Cable.—A similar Cable produced by the common White Slug.—The Principle of Elasticity.—Elastic Cable of the Garden Spider.—Tendrillous Cables of the Pea and the Bryony.—The Vallisneria, and its Development through the Elastic Cable.—Proposed Submarine Telegraph Cable.—The Anchor, Grapnel, and their Varieties.—Natural Anchors.—Spicule of Synapta.—The Grapnel, natural and artificial.—Ice-anchor and Walrus Tusks.—The Mushroom Kedge.—The Flesh-hook.—Eagle-claw.—The Grapple-plant of South Africa.—The Drag.

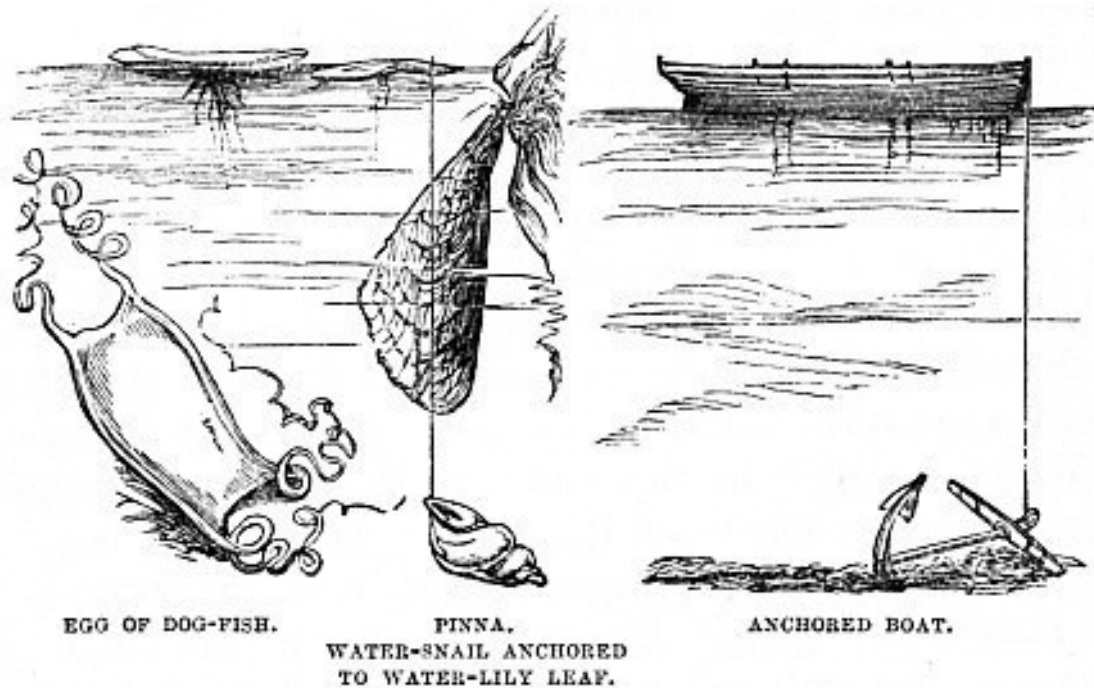
AMONG the most important accessories to a ship are the Cable, by which she can be anchored to the bed of the sea, and the ropes called “warps,” by which she can be fastened to the land.

Perhaps my readers may not know the old riddle—“How many ropes are there on board a man-of-war?” The non-nautical individual cannot answer, but the initiated replies that there are only three, namely, the man-rope, the tiller-rope, and the rope’s-end, all the others being “tacks,” “sheets,” “hauyards,” “stays,” “braces,” &c.

Formerly cables were always made of hemp, enormously thick, and most carefully twisted by hand. Now, even in small vessels, the hempen cable has been superseded by the iron chain, and this for several reasons.

In the first place, it is much smaller in bulk, and therefore does not occupy so much room. In the next place, it is even lighter than the hempen cable of corresponding strength; and, in the third, its specific gravity—*i.e.* its weight when compared with an equal bulk of water—is so great, that when submerged, it falls into a sort of arch-like form, and so attains an elasticity which takes off much of the strain on the anchor, and protects it from dragging.

We will now look to Nature for Cables.



The natural cable which will first suggest itself is evidently that of the Pinna Shell (*Pinna pectinata*), which fixes its shell to some rock or stone with a number of silk-like threads, spun by itself, and protruding from the base, just as a vessel on a lee shore throws out a number of cables. The threads which compose the “byssus,” as it is called, are only a few inches in length, and apparently slight. They are, however, really strong, and by acting in unison enable the shell, though sometimes two feet in length, to be held firmly to the rock. I may here mention that they have been occasionally woven into gloves, and other articles of apparel, to which their natural soft grey-brown hue gives a very pleasing appearance.

A still more familiar instance of a natural marine cable is given by the common Mussel, which can be found in thousands on almost every solid substance which affords it a hold. Even copper-bottomed ships are often covered with Mussels, all clinging by their natural cables, and it is thought that the cases which sometimes occur of being poisoned by eating Mussels, or “musselled,” as the malady is called by the seafaring population, are due to the fact that the Mussels have anchored themselves to copper, and have in consequence imbibed the verdigris.

Passing from salt to fresh water, we come to a natural cable which is very common, and yet, on account of its practical invisibility, is almost unknown, except by naturalists. I refer to the curious cable which is constructed by the common Water-snail (*Limnaea stagnalis*), which has already been mentioned in its capacity of a boat.

This creature has a way of attaching itself to some fixed object, such as a water-lily leaf, by means of a gelatinous thread, which it can elongate at pleasure, and by means of which it can retain its position in a stream, or in still water can sink itself to the bottom, and ascend to the same spot. This cable seems to be made of the same glairy secretion as that which surrounds the egg-masses which are found so plentifully on leaves and stones in our fresh waters, and, like that substance, is all but invisible in the water, so that an inexperienced eye would not be able to see it, even if it were pointed out.

Slight, gelatinous, and almost invisible in the water as is this thread, its strength is very much greater than might be supposed. Not only can a mollusc be safely moored in the water by such a cable, but it can be actually suspended in the air, as may be seen from a letter in Hardwicke’s *Science Gossip* for 1875, p. 190:—

“Last summer (September 29) I met with the following unusual fact. In a green-house, from a vine-leaf which was within a few inches of the glass ... a slug was hanging by a thread, which was more than four feet in length, not unlike a spider-web, but evidently much stronger.

“The slug was descending by means of this thread, and, as the glutinous matter from the under part of the body was drawn out by the weight of the creature, it was consolidated into a compact thread by the slug twisting itself in the direction of the hands of a clock, the power of twisting being given by the head, and the part of the body nearest the head being turned in the direction of the twist. There was no tendency to turn in the contrary direction. Evidently the thread became hard as soon as it was drawn away from the body.

“By wetting the sides of slips of glass, I secured two specimens of the thread. In one of these, part was stretched, and part quite loose, the latter appearing flat when seen through a microscope. The thread, which was highly elastic, was increased about three inches in a minute. The slug was white, and about an inch and a half in length.”

Now we come to the elastic system of the Chain Cable, and find it anticipated in Nature in various ways.

One curious example was that of a Spider, which found its wheel-like net in danger from a tempestuous wind. The Spider descended to the ground, a depth of about seven feet, and, instead of attaching its thread to a stone or plant, fastened it to a piece of loose stick, hauled it up a few feet clear of the ground, and then went back to its web. The piece of stick thus left suspended acted in a most admirable manner, giving strength and support, and at the same time yielding partly to the wind.

By accident the thread became broken, and the stick, which was about as thick as an ordinary pencil, and not quite three inches in length, fell to the ground. The Spider immediately descended, attached another thread, and hauled it up as before. In a day or two, when the tempestuous weather had ceased, the Spider voluntarily cut the thread, and allowed the then useless stick to drop.

A curious example of the elastic cable is seen in the egg-case of the Dog-fish, which is given on page [35](#). The egg-case is formed like that of the common skate, and has a projection from each of its angles. But the projections, instead of being mere flattened horns, are lengthened into long elastic strings, tapering towards the ends, and twisted spirally, like the tendrils of a grape-vine.

These tendril-like appendages twist themselves round seaweeds and other objects, and, on account of their spiral form, can hardly ever be torn from their attachments. Sometimes after a storm the egg is thrown on the shore, still clinging to the seaweed, but to find an egg detached is very rarely done.

I have already mentioned the tendrils of the vine, and their great strength. The reader may remember the corresponding cases of the Pea and the Bryony, the latter being a most remarkable example of the strength gained by the spiral form. It clambers about hedges, is exposed to the fiercest winds, has large and broad leaves, and yet such a thing as a Bryony being blown off a hedge is scarcely, if ever, seen. I never saw an example myself, though I have had long experience in hedges.

Another excellent example of this principle is found in the Vallisneria plant, which of late years has become tolerably familiar to us through the means of fresh-water aquaria, though it is not indigenous to this country.

In this plant the elastic power of the spiral cable is beautifully developed. It is an aquatic plant, mostly found in running waters, and has a most singular mode of development. It is diœcious—*i.e.* the male, or stamen-bearing, and the female, or pistil-bearing flowers, grow upon separate plants.

It has to deposit its seeds in the bed of the stream, and yet it is necessary that both sets of flowers should be exposed to the air and sun before they become able to perform their several duties. Add to this the fact that the male flower is quite as small in proportion to the female as is the case with the lac and scale insects, and the problem of their reaching each other becomes apparently intricate, though it is solved in a beautifully simple manner.

Fertilisation cannot be conducted by means of insects, as is the case with so many dioecious terrestrial plants, and it is absolutely necessary that actual contact should take place between them. This difficult process is effected as follows:—

The female flowers are attached to a very long spiral and closely coiled footstalk, and, when they are sufficiently developed, the footstalk elongates itself until the flower rests on the surface of the water, where it is safely anchored by its spiral cable, the coils yielding to the wavelets, and keeping the flower in its place.

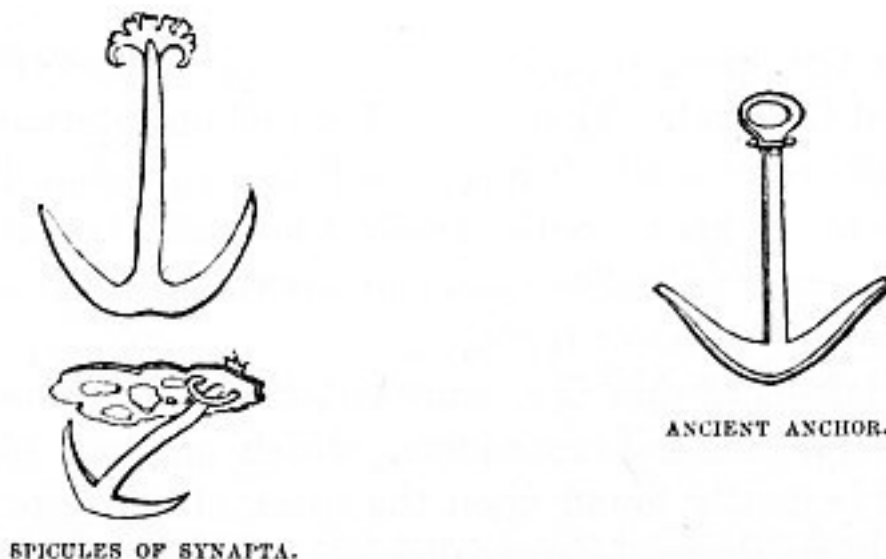
Meanwhile the tiny male flowers are being developed at the bottom of the river, and are attached to very short footstalks. When they are quite ripe they disengage themselves from their footstalks, and rise to the surface of the river. Being carried along by the stream, they are sure to come in contact with the anchored female flowers. This having been done, and the seeds beginning to be developed, the spiral footstalk again coils itself tightly, and brings the seeds close to the bed of the stream, where they can take root.

There are other numerous examples, of which any reader, even slightly skilled in botany, need not be reminded, most of them being, in one form or another, modifications of the leaf or the petal, which, after all, are much the same thing. The vine and passion-flower are, however, partial exceptions.

I may here mention that soon after the failure of the first Atlantic telegraph cable, an invention was patented of a very much lighter cable, enclosed in a tube of india-rubber, and being coiled spirally at certain distances, so that the coils might give the elasticity which constitutes strength. The cable was never made, its manufacture proving to be too costly; but the idea of lightness and elasticity, having been evidently taken from the spiral tendrils of the bryony, was certainly a good one, and I should have wished to see it tried on a smaller scale than the Atlantic requires.

As a natural consequence, after the cable comes the Anchor, which in almost every form has been anticipated by Nature, whether it be called by the name of anchor, kedge, drag, or grapnel.

On the accompanying illustrations are shown a number of corresponding forms of the Anchor, together with a few others, which, although they may not necessarily be used in the water, are nevertheless constructed on the same principle—*i.e.* for the purpose of grappling.

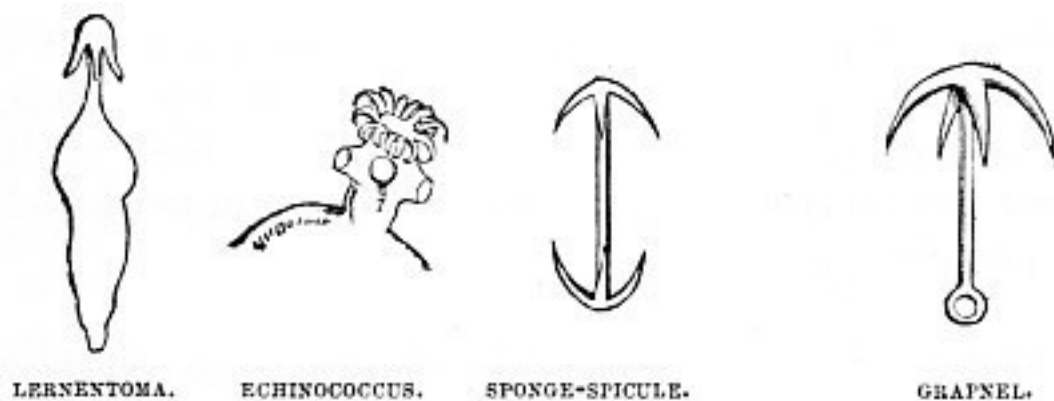


One of the most startling parallels may be seen on the right hand of the illustration, the figure having been drawn from an old Roman coin. On the other side of the same illustration may be seen an anchor so exactly similar in form, that the outline of the one would almost answer for that of the other. This object is a much-magnified representation of a spicule which is found on the skin of the

Synapta, one of the so-called Sea-slugs, which are so extensively sold under the name of Bêche de Mer. It forms one of the curious group called the Holothuridæ.

Each of these anchors is affixed to a sort of open-worked shield, as shown above, and on the left hand; and it is a curious fact that in the various species of Synapta the anchor is rather different in form, and the shield very different in pattern. They are lovely objects, and I recommend any of my readers who possess a microscope to procure one. They need a power of at least 150 diameters to show their full beauties.

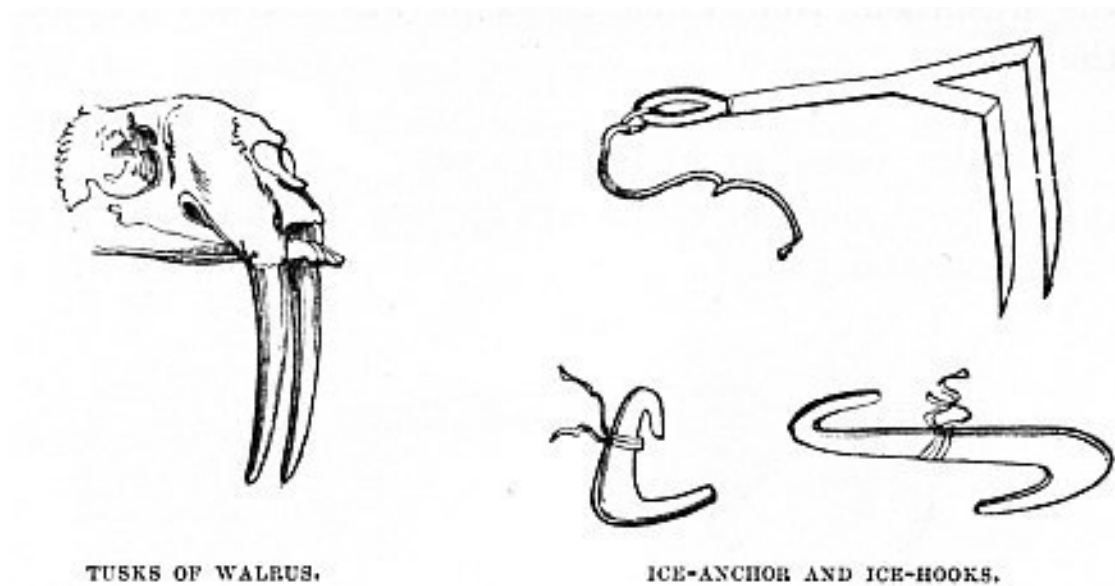
An ordinary Grapnel is here shown, and in the corresponding position on the opposite side is an almost exactly similar object, except that it is double, having the grapnel at both ends of the stem. This is a spicule of a species of sponge, and is one of the vast numbers of which the sponge principally consists.



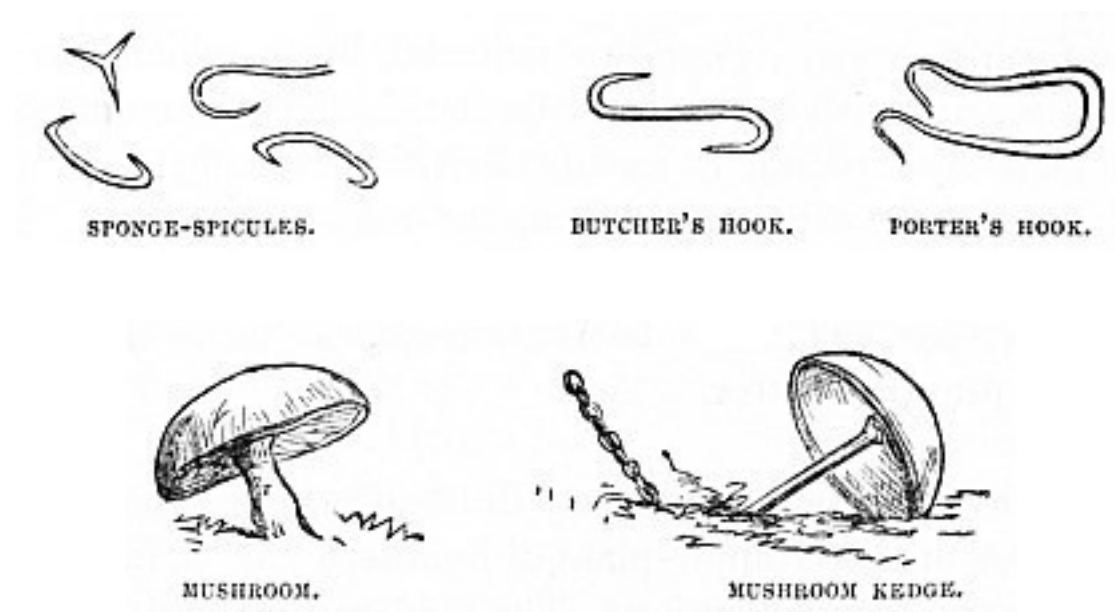
Next to the sponge-spicule is a still more perfect example of a natural Grapnel. This is the head of an internal parasite called Echinococcus, which holds itself in its position by means of the circle of hooks with which the head is surrounded. These hooks are easily detached, and have a curious resemblance to the claw of the lion or tiger.

On the left-hand side is a representation of a parasitic crustacean animal called Lernentoma, which adheres to various fishes, and is mostly found upon the sprat, clinging to the gills by means of its grapnel-shaped head.

On the right hand of the accompanying illustration is an ice-anchor, copied from one of those which were taken out in the Arctic expedition of 1875. Opposite is the skull of the Walrus, the tusks of which are said to be used for exactly the same purpose. Below are ice-hooks, also used for the same expedition.



The next illustration exhibits a butcher's hook and a common porter's hook, by which he lifts sacks on his back; and opposite them are some sponge-spicules, the similarity of which in form is so remarkable that the former might have been copied from the latter.



Our next sketch shows a remarkable example of similitude in form. There are certain small anchors called Kedges, which are very useful for mooring a boat where no great power of resistance has to be overcome, and a large anchor would be cumbersome. One of these is called, from its shape, the "Mushroom Kedge," and is very useful, as, however it may be dropped, some part of the edge is sure to take the ground. This Kedge is shown on the right hand of the illustration, and the Mushroom, from which its shape was borrowed, is seen on the left.

We now come to some more examples of the principle of the Grapnel, some of which are applied to nautical, and others to terrestrial objects.



EAGLE-CLAW.



FLESH-HOOK.

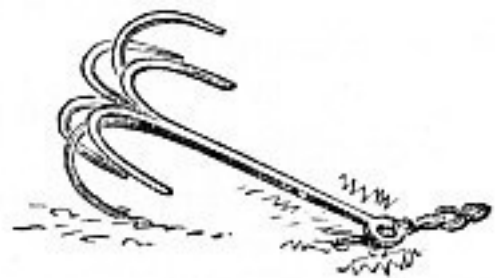
The right-hand upper figure represents the “Flesh-hook,” used for taking boiled meat out of the caldron, so familiar to us by the reference to it in Exodus xxvii. 3, and the still better-known allusion to its office in 1 Samuel ii. 13, 14. In the former passage, even the material, brass, which was really what we now call bronze, is mentioned, and it is a curious fact that all the specimens in the British Museum, from one of which the drawing was taken, are made of bronze. I need hardly state that the hollow handle is meant to receive a wooden staff.

On comparing this figure with that of the Eagle’s foot on the opposite side, the reader cannot but be struck with the exact resemblance between the two. Indeed, there is very little doubt that the flesh-hook was intentionally copied from the foot of some bird of prey. Perhaps the Osprey would have furnished even a better example than the Eagle, the claws being sharper and more boldly curved, so as to hold their slippery prey the better.

On the left hand of the next illustration is a figure of the seed-vessel of the Grapple-plant of Southern Africa, drawn from a specimen in my collection. The seed-vessel is several inches in length, and the traveller who is caught by a single hook had better wait for assistance than try to release himself. The stems of the plant are so slender, and the armed seed-vessels so numerous, that in attempting to rescue one portion of the dress, another portion becomes entangled, and the traveller gets hopelessly captured. Besides the hooks of the seed-vessels, the branches themselves are armed with long thorns, set in pairs. The scientific name of this plant is *Uncinaria procumbens*, the former word signifying “a hook,” and the latter “trailing.” It is also known by the popular name of Hook-plant.



GRAPPLE-PLANT.



DRAG.

In the late Kafir wars the natives made great use of this and other plants with similar properties, their own naked, dark, and oiled bodies slipping through them easily and unseen, while the scarlet coats of the soldiers were quickly entangled, and made them an easy mark for the Kafir’s spear. In this way many more of our soldiers were killed by the spears than by the bullets of their enemies.

Opposite to the Grapple-plant is shown the common Drag, which is utilised for so many purposes. Generally it is employed for recovering objects that have sunk to the bottom of the water, and its use by the officers of the Humane Society is perfectly well known, the Drag being sometimes affixed to the end of a long pole, like the flesh-hook already described, and sometimes tied to a rope.

It can also be used as an anchor, after the manner of a kedge, and has been often employed in naval engagements for the purpose of drawing two ships together, and preventing the escape of the vessel which is being worsted. My relative, the late Admiral Sir J. Harvey, K.B., used drags in this manner, and secured two French ships, one on either side, namely, *L'Achille* and *Le Vengeur*. The first was sunk, and the second captured.

CHAPTER V. SUBSIDIARY APPLIANCES. Part III.—The Boat-hook and Punt- pole.—The Life-buoy and Pontoon-raft

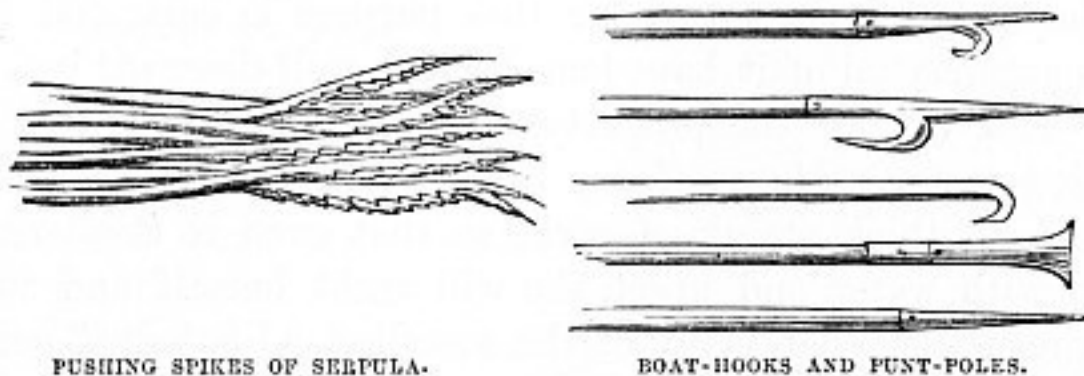
The Boat-hook and its varied Uses.—The Earth-worm and the Serpula.—
Microscopic Boat-hooks.—The Life-belt.—Life-boats and their Structure.—Uses
of Cork.—Wine Corks made serviceable.—The Life-collar.—Portuguese Man-of-
war.—Captain Boyton's Life-dress.—The Life-raft.—Victualling a Yacht and Boat.
—The Janthina and its Air-vessels.—Cask-pontoon—Pottery-raft and its Uses.

AS all rowing men know, an indispensable appliance to the boat is the Boat-hook, which can be used either as a pole, wherewith to push the boat along, or as a grapnel, by which it can be drawn towards the shore or a ship. As the latter portion has been discussed at the close of the preceding chapter, we may proceed to the former.

Every one knows how a boat may be propelled by a pole pressed against the bank or the bottom of the water, and that there are certain boats, called punts, which are propelled in no other way.

Now, the punt-poles and boat-hooks, of which some examples are given in the accompanying illustration, have long been anticipated in Nature, there being many creatures which have no other mode of progression; such, for example, as the common Earth-worm, which pushes itself along by certain bristles which project from the rings of which the body is composed, and which have the power of extension and contraction to a wonderful extent. As, however, I shall advert to these in another part of the work, I will content myself at present with a single example, namely, the beautiful marine worm known as the Serpula.

This worm lives in a shelly tube, which is lined with a delicate membrane, up and down which it passes with ease, ascending slowly, but generally descending with such wonderful rapidity that the eye cannot follow its movements. The latter movement will be explained in a subsequent part of the book, and we will at present only treat of the former.



If the creature be removed from the tube, and carefully examined, a number of projections will be seen, in each of which is a perforation. If the animal be pressed, a slight glass-like bristle passes through the perforation, and can easily be removed. If properly treated, and placed under a high power of the microscope, the tiny bristle resolves itself into the remarkable object which is shown on the left hand of the illustration.

It consists of a number of spear-like rods, each having a straight shaft, and a curved and pointed tip, deeply barbed on the inner portion of the curve. These curious bundles of spicules can be protruded or retracted at pleasure, and, as they are all directed backwards, it is evident that when they are pushed against the sides of the tube, either the points or the barbs must catch against the membrane which lines the tube, and so propel the animal upwards. When it wishes to descend, it uses another set of implements, and withdraws the first within their sheaths.

This is exactly analogous to the mode of progression employed by punters, who, after they have placed the pole against the bed of the stream, and run along the punt so as to push it as fast as possible, immediately withdraw the pole, and take it to the head of the punt, ready for another push. This, as the reader will see, is exactly the plan pursued by the *Serpula* in lengthening itself when it wishes to advance, and so to press its spicules against the sides of its tube, and in shortening itself and withdrawing the spicules ready for another push.

Another needful accessory of vessels now comes before us, namely, the capability of forming rafts or life-belts, which will float under any circumstances. Here, again, every human invention of which I know has been anticipated by Nature. Take, for example, the familiar instance of the cork life-belt and the cork edgings of the life-boat. Both are constructed on the same principle, *i.e.* the maintenance of cells which are filled by air instead of water, and are impervious to the latter.

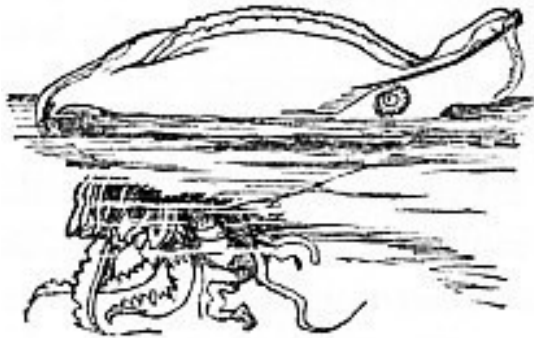
The material most used for this purpose is cork, and life-belts constructed of it have long been in well-deserved use, the cork-bark having the property of holding much air and excluding water. Many of our life-boats are furnished with a broad and thick streak of cork, so that even if the boat be filled with water and upset, she will right herself and swim. I regret to say that many of the so-called “life-belts” which are offered for sale ought rather to be called “death-belts,” they having been found to be filled with hay and straw, with only a few shavings of cork just under the covering of the belt.

Indeed, so buoyant is this substance that a very efficient belt can be made by stringing together three or four rows of ordinary wine corks, and tying them round the neck like a collar. Under these circumstances it is simply impossible to sink, and though any one may collapse from exhaustion, drowning is almost out of the question. The now well-known cork mattress, which is used in many ships, is another example of the same principle.

Lately there has been invented a “life-collar,” which possesses similar advantages, but occupies less space when not wanted. It is nothing more than a tube of caoutchouc, which can be inflated at pleasure, and tied round the neck. The ordinary life-belt goes round the waist, and needs much more material without obtaining a better result, which is simply the keeping of the mouth and nostrils out of the water.

Perhaps the most buoyant of living beings is the Portuguese Man-of-war (*Physalis pelagicus*), which floats on the surface of the ocean like a bubble. It can at pleasure distend itself with air and float, or discharge the air and sink.

Now, there is a very remarkable swimming dress, which, though not entirely invented, was at least perfected by Captain Boyton, and which, as it enabled the wearer to cross from France to England under rather unfavourable circumstances, is clearly a most valuable invention.



PORTUGUESE MAN-OF-WAR.



CAPTAIN BOYTON'S LIFE-DRESS.

Whether the inventor knew it or not I cannot say, but the Boyton life-dress is simply a modification of the *Physalis*, being capable of dilatation with air at will.

So much for the individual life-belt, and we will now pass to those which are intended to sustain more than one individual. It has almost invariably been found that when a ship has been wrecked on a rock, or stove in by the sea, that, although there may be plenty of boats, there is great difficulty in getting them into the water rightly.

Now, if parts of the ship itself could be made of materials which could not be sunk except by enormous pressure, and which might be released by a touch if the vessel were sinking, it is evident that many lives would be saved which have now been lost.

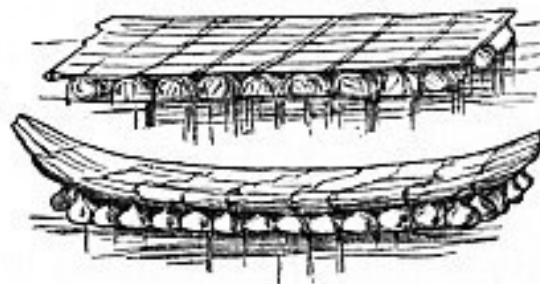
And if such movable parts of the vessel were supplied with water and provisions in air-tight cases, there is no doubt that the number of "missing" ships would be very greatly diminished. I remember an instance where a yacht was "hung up" on a mud-bank, whence there was no escape, for twenty-four hours, and there was one sandwich on board to be divided among the owner, two men, and a boy. Of course the boy had the sandwich, and the men sustained themselves as well as they could with tea, of which there was, fortunately, a canister on board. As it was, they were some thirty-six hours without food.

After such an experience the owner had special lockers made in the yacht and her boat, containing biscuit, potted meats, water, wine, spirits, tobacco, tea, an "etna" for heating the water, and matches. Of course these were on a smaller scale in the boat; but several thick rugs were also stowed away, in case of being separated from the yacht at night. It so happened that they were never needed; but the sense of security which they imparted was worth ten times the expense and trouble, which included a careful inspection of all the stores before each voyage.

In Nature there is just such a raft as is needed, capable of carrying a heavy freight, and which cannot be upset. And it is rather remarkable that it has been unconsciously imitated in various parts of the world.



JANTHINA AND AIR-RAFT.



CASK-PONTOON.
POTTERY-RAFT OF THE NILE.

This is the singular apparatus attached to the Violet Snail (*Janthina communis*), which is common enough in the Atlantic, and derives its name of Violet-shell from its beautiful colour. The chief interest, however, centres in the apparatus which is popularly called the “raft,” and which sustains the shell and eggs. It is made of a great number of air-vessels, affixed closely to each other, and by the curious property of bearing its cargo slung beneath it instead of being laid upon it.

Beneath the raft are the eggs, or rather, the capsules which contain the eggs, and at one end is the beautiful violet shell itself. The floating power of the raft is really astonishing, and even in severe tempests, when it is broken away from the animal, the raft continues to float on the surface of the waves, bearing its cargo with it.

On the opposite side of the illustration are two examples of rafts constructed so exactly on the same principle as that of the Violet Snail, that they both might have been borrowed from it.

The upper is the kind of raft which has often been constructed by sailors when trying to escape from a sinking ship, or by soldiers when wishing to convey troops across a river, and having no regular “pontoons” at hand. It is made simply by lashing a number of empty casks to a flooring of beams and planks.

The amount of weight which such a structure will support is really astonishing, as long as the casks remain whole, and to upset it is almost impossible. Even cannon can be taken across wide expanses of water in perfect safety, and there is hardly anything more awkward of conveyance than a cannon, with its own enormous and concentrated weight, and all the needful paraphernalia of limber, ammunition (which may not be wetted, and of immense weight), horses, and men.

Yet even this heterogeneous mass of living and lifeless weight can be carried on the cask-raft, which is an exact imitation of the living raft of the Violet Snail.

Beneath the cask-pontoon is to be seen a sketch of a very curious vessel which is in use on the Nile, and I rather think on the Ganges also, though I am not quite sure. It is formed in the following manner:—

In both countries there are whole families who from generation to generation have lived in little villages up the river, and gained their living by making pottery, mostly of a simple though artistic form, the vessel having a rather long and slender neck, and a more or less globular body.

When a man has made a sufficient number of these vessels, he lashes them together with their mouths uppermost, and then fixes upon them a simple platform of reeds. The papyrus was once largely used for this purpose, but it seems to be gradually abandoned.

He thus forms a pontoon exactly similar in principle with the cask-pontoon which has just been described. Then, taking his place on his buoyant raft, he floats down the river until he comes to some populous town, takes his raft to pieces, sells the pots and reeds, and makes his way home again by land.

WAR AND HUNTING

CHAPTER I. THE PITFALL, THE CLUB, THE SWORD, THE SPEAR AND DAGGER

Analogy between War and Hunting.—The Pitfall as used for both Purposes.—African Pitfalls for large Game, and their Armature for preventing the Escape of Prey.—Its Use in this Country on a miniature scale.—Mr. Waterton's Mouse-trap.—Pitfall of the Ant-lion, and its Armature for preventing the Escape of Prey.—The Club and its Origin.—Gradual Development of the Weapon.—The "Pine-apple" Club of Fiji.—The Game of Pallone and the "Bracciale."—The Irish Shillelagh.—Clubs and Maces of Wood, Metal, or mixed.—The Morgenstern.—Ominous Jestings.—Natural Clubs.—The Durian, the Diodon, and the Horse-chestnut.—The Sword, or flattened and sharpened Club.—Natural and artificial Armature of the Edge.—The Sword-grass, Leech, and Saw-fish.—Spears and Swords armed with Bones and Stones.—The Spear and Dagger, and their Analogies.—Structure of the Spear.—The Bamboo as a Weapon of War or Hunting.—Singular Combat, and its Results.

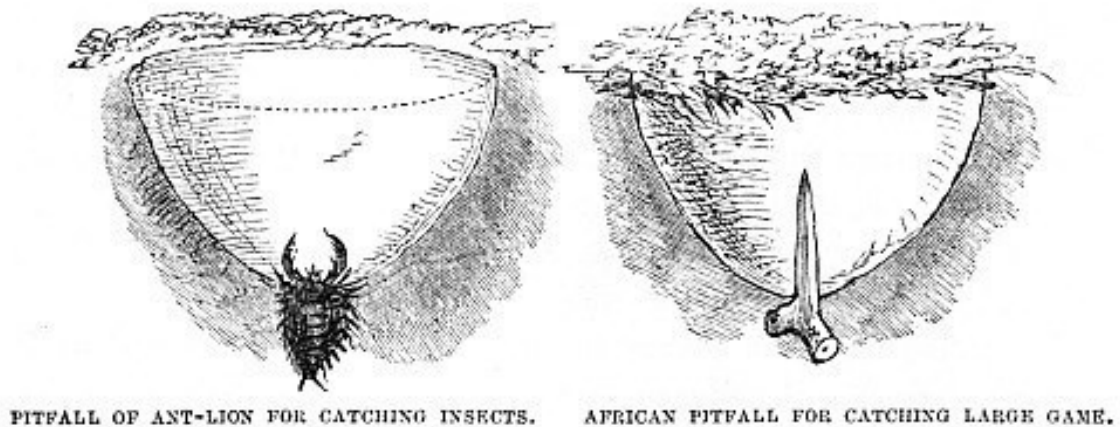
THE two subjects which are here mentioned are practically one, the warfare being in the one case carried on against mankind, and in the other against the lower animals, the means employed being often the same in both cases.

The Pitfall

One of the simplest examples of this double use is afforded by the Pitfall, which is employed in almost every part of the world, and, although mostly used for hunting, still keeps its place in warfare.

On the right hand of the accompanying illustration is shown a section of the Pitfall which is so commonly used in Africa for the capture of large game. It is, as may be seen, a conical hole, the bottom of which is armed with a pointed stake. Should a large animal fall into the pit, the shape of the sides forces it upon the stake, by which it is transfixed. Even elephants of the largest size often fall victims to this simple trap. It is only large enough to receive the fore-legs and chest, but that is quite sufficient to cause the death of the animal, the stake penetrating to the heart.

Many a hunter has fallen into these traps, and found great difficulty in escaping, while some have not escaped at all. Indeed, in many parts of Southern Africa, when part of one tribe is about to visit another, the pitfalls are always unmasked, lest the intended guests should fall into them.



Even without the spike, the elephant would scarcely be able to save itself, owing to its enormous weight, unless helped out by its comrades before the hunters came up. Indeed, many pitfalls are intentionally made for this purpose, and are of a different shape, *i.e.* about eight feet in length and four in breadth.

In those which are made for the capture of the giraffe, the pit is very deep, and the place of the stake is occupied by a transverse wall, which prevents the feet of the captive from touching the ground, and keeps it suspended until the hunters can come and kill it at leisure.

Even in Belgium and our own country the pitfall is in use. When the field-mice were devastating the districts about Liege some years ago, their ravages were effectually checked by pitfalls, in which they were caught by bushels, the pitfalls being simple holes some two feet deep, and made wider below than above.

The late Mr. Waterton contrived to rid his garden of field-mice by pitfalls constructed on the same principle, though more permanent. Finding that the little animals made great havoc among his peas just as they were starting out of the ground, he buried between the rows a number of earthen pickle-jars, sinking them to the level of the ground. He then rubbed the inside of the neck with bacon, and left them. The mice stooped down to lick off the bacon, fell into the jars, and, the neck being narrow and the sides slippery, they could not get out again.

On the left hand of the illustration is the section of a pitfall made by the well-known Ant-lion (*Myrmeleo*), of which there are several species. The history of this wonderful insect is so familiar to us that it need not be repeated at length. Suffice it to say that it digs conical pitfalls in loose sandy soil, and that it places itself at the bottom of the pit, securing the insect victims with its jaws just as the larger animals are secured by the stake of the human hunter.

It makes no false cover, as does the human hunter, but it always chooses soil so loose that if an insect approach the edge, the sand gives way, and it goes sliding down into the pit, whence its chance of escape is very small, even were there no deadly jaws at the bottom ready to receive it.

The Club

The simplest of all offensive weapons is necessarily the Club. At first, this was but a simple stick, such as any savage might form from a branch of a tree by knocking off the small boughs with a stone or another stick. Such clubs are still used in Australia, and I have several in my collection.

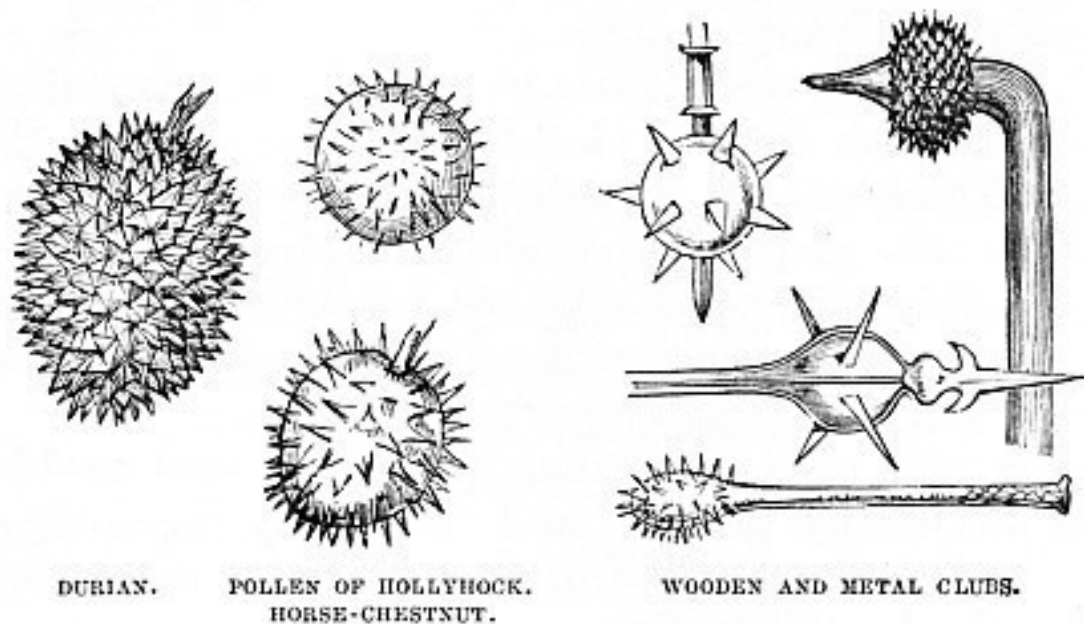
Then the inventive genius of man improved their destructive power by various means. The most obvious plan was to add to the force of its blow by simply making one end much thicker and heavier than the other. This is done in the “Knob-kerry” of Southern Africa, and it is worthy of remark that

in Fiji a weapon exists so exactly like the short knob-kerry of Africa, that an inexperienced eye would scarcely be able to distinguish between them.

The next plan was to arm the enlarged head with projecting pieces or spikes, sometimes cut out of the solid wood, and sometimes artificially inserted. The “Shillelagh” of Ireland is a simple example of this kind of club. One of the best and most elaborate examples of this sort of weapon is the “Pine-apple” Club of Fiji, a figure of which may be seen in the illustration, drawn from a specimen in my collection.

It is made in the most ingenious manner from a tree which is trained for the purpose. There are certain trees belonging to the palm tribe which possess “aërial” roots, *i.e.* subsidiary roots, which surround the trunk at some distance from the ground, and assist in supporting it. Some trees have no central root, and are entirely upborne by the aërial roots, while others have both.

One of these latter is selected, and when it is very young is bent over and fastened to the ground almost at right angles, as shown in the illustration. When it has grown to a sufficient age it is cut to the requisite length, the central root is sharpened to a point, and the aërial roots are also cut down in such a way that they radiate very much like the projections on a pine-apple. This is really an ingenious weapon, for if the long and sharpened end should miss its aim, the projections would be tolerably sure to inflict painful if not immediately dangerous injuries.



As the pine-apple is so well known, I have given in the opposite side of the illustration a figure of the Durian, a large Bornean fruit, which is covered with projections almost identical in appearance with those of the pine-apple club, and almost equally hard and heavy.

Perhaps some of my readers may have heard of the grand Italian game of Pallone, the “game of giants,” as it has been called. The ball, which is a large and rather heavy one, weighing more than twice as much as a cricket-ball, is struck with a wooden gauntlet reaching nearly half-way up the forearm. The original gauntlet was cut entirely out of the solid wood, and exactly resembled the exterior of the Durian. The modern gauntlet, however, has the spikes fixed separately into a wooden frame, so that they can be replaced if broken in the course of the game. The principle, however, is identical in all three cases. The technical name of this gauntlet is Bracciale.

The next improvement was to add still further to the destructive powers of the club by arming it with stones, so as to make it harder and heavier. Sometimes a stone is perforated, and the end of the club forced into it. Sometimes the stone is lashed to the club, and sometimes a hole is bored in

the club, and the stone driven into it. This kind of club, made of a sort of rosewood, may be found among some of the tribes inhabiting the district of the Essequibo.

The next improvement was to make the weapon entirely of metal, and such clubs are plentiful in every good collection of arms. There was, for example, the common mace, which was used for the purpose of stunning an adversary clothed in armour which the sword could not penetrate. As this, however, was nothing more than an ordinary wooden club executed in iron, we need not produce examples.

Other and more complicated forms were soon made, and were wonderfully valuable until the rapidly improving firearms kept combatants at a distance, and rendered a hand-to-hand fight almost impossible.

Three examples of such clubs are given in the illustration, and are taken from Demmin's valuable work called "Weapons of War."

The upper left-hand specimen is called Morgenstern, *i.e.* Morning Star. It is a large, heavy wooden ball studded with steel spikes, and affixed to a handle usually some six or seven feet, but sometimes exceeding eleven feet, in length. It was chiefly used by infantry when attacking cavalry, the long shaft enabling the foot-soldier to be tolerably sure of dealing the cavalier or his horse a severe blow, while himself out of reach of the latter's sword.

Behind it is another Morgenstern in which there is an improvement, the armed ball being furnished at the end with a spike, so that it could be used either as a mace or a spear.

The commonest form of the Morning Star is shown below, and is thus described by Demmin:—

"This mace had generally a long handle, and its head bristled with wooden or iron points. It was common among the ancients, for many museums possess several fragments of these weapons belonging to the age of bronze.

"The Morning Star was very well known and much used in Germany and Switzerland. It received its name from the ominous jest of wishing the enemy 'good morning' with the Morning Star when they had been surprised in camp or city.

"This weapon became very popular on account of the facility and quickness with which it could be manufactured. The peasants made it easily with the trunk of a small shrub and a handful of large nails. It was also in great request during the wars of the peasantry which have devastated Germany at different times, and the Swiss arsenals possess great numbers of them."

One of these primitive weapons may be seen in the lower figure of the illustration.

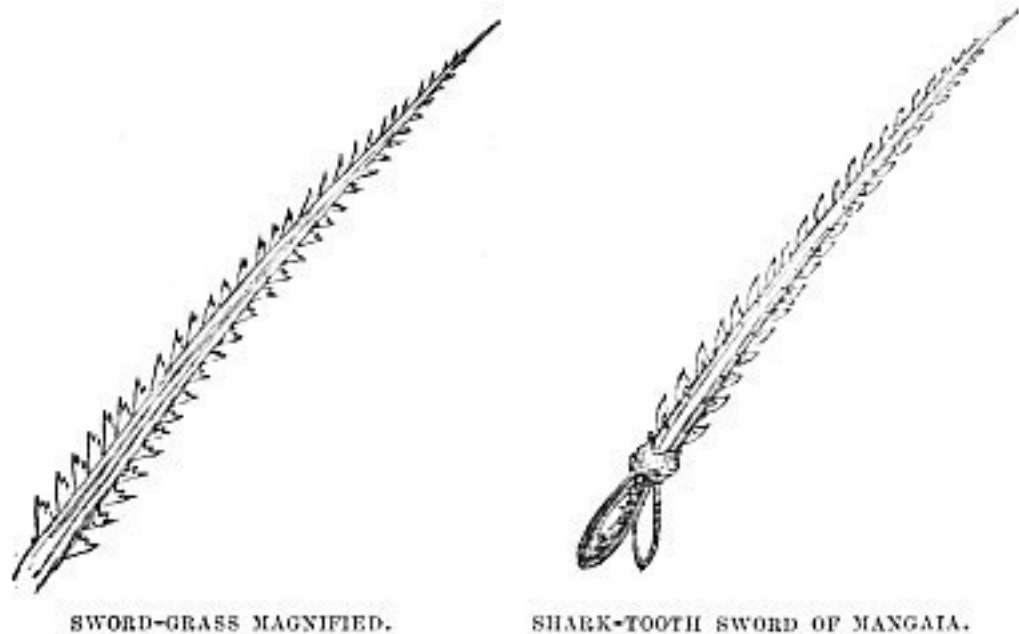
Sometimes the spiked ball was attached to a chain, and fastened to the end of a handle varying greatly in length, measuring from two to ten feet. One of these weapons may be seen in the Guildhall of London, being held by one of the celebrated giants.

If the reader will now turn to the illustration on page [53](#), he will see that on the right of the Durian there are two spherical objects covered with spikes. The upper is the pollen of the Hollyhock, and the lower the common Horse-chestnut. The reader will see that these are precisely similar in form to the spiked balls of the Morgenstern, whether they be used at the end of a staff or slung to a chain. There are many similar examples in the vegetable kingdom which will doubtless suggest themselves to the reader, but these are amply sufficient for this purpose.

Then, in the animal world, the curious Diodons, sometimes called Urchin-fishes, or Prickly Globe-fishes, are good examples. These fishes are covered with sharp spines, and, as they have the power of swelling their bodies into a globular form, the spikes project on all sides just like those of the pollen or chestnut. There is a specimen in my collection, which, if the tail and fins were removed, and a cast taken in metal, would make a very good Morgenstern ball.

The Sword

The next improvement on the club was evidently to flatten it, and sharpen one or both edges, so as to make it a cutting as well as a stunning implement—in fact, the club was changed into a Sword.



A good example of this weapon in its simplest form is the wooden sword of Australia, now an exceedingly rare weapon. It looks like a very large boomerang, but is nearly straight, and is made from the hard, tough wood of the gum-tree. Travellers say that the natives can cut off a man's head with this very simple weapon.

I just missed obtaining one of these swords from a man-of-war, but, unfortunately, a few hours before my arrival the zealous first lieutenant had ordered a large collection of savage weapons to be thrown overboard, among which were several Australian swords.

Finding that the edges were not sufficiently sharp, and were liable to break, the maker next turned his attention to arming them with some substance harder than wood. Various materials were used for this purpose, some of which will be mentioned.

One of these is given in the illustration, and is taken from a specimen in my collection. It is made of wood, rather more than two feet in length, and would in itself be an insignificant weapon but for its armature.

This consists of a number of sharks' teeth, which are fixed along either side, and are a most formidable apparatus, each tooth cutting like a lancet-blade, and not only being very sharp, but having their edges finely notched like the teeth of a saw. I have a series of these weapons in my collection, some being curved, some straight, and one very remarkable weapon having four blades, one straight and long blade in the centre, and three curved and short blades springing from the handle towards the point.

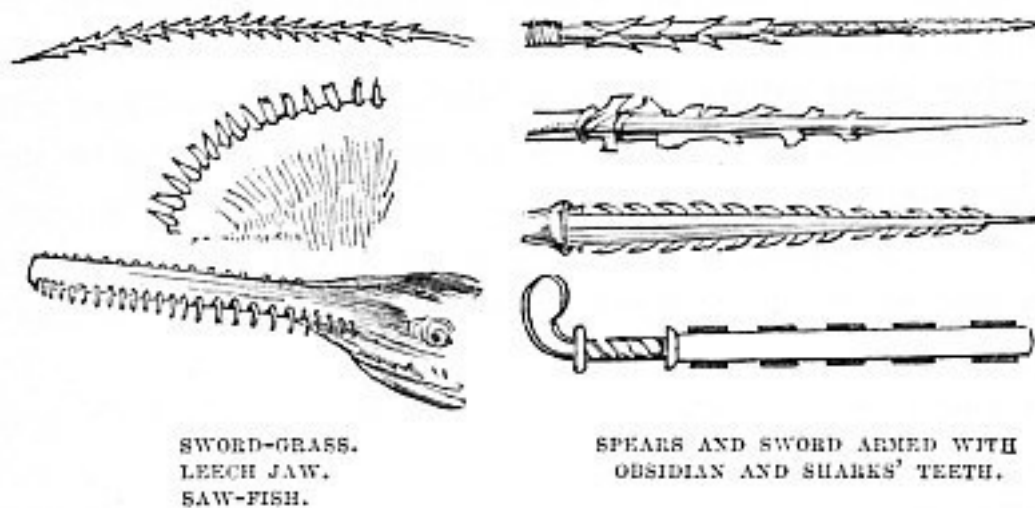
Opposite the shark-tooth sword is an object which might almost be taken for a similar weapon, but is, in fact, nothing but a common grass-blade, such as may be found in any of our lanes. I suppose that most of my readers must at some time have cut their fingers with grass, and the reason why is shown in the illustration, which represents a much-magnified blade of grass. The edges of the leaf are armed with sharp teeth of flint, set exactly like those of the sword, with their points directed

towards the tip of the blade. The whole of the under surface of the blade is thickly set with similar but smaller teeth, arranged in the same manner. I have just brought a blade of grass from a lane near my house, and when it was placed under the half-inch power of the microscope, the resemblance to the sword was absolutely startling to some spectators who came to look at it.

As if to make the resemblance closer, many savage weapons are edged with flat stones, flint chips, or pieces of obsidian, so that the flint teeth of the grass are exactly copied by the flint edgings of the sword. The old Mexican swords were nearly all edged with obsidian, as is seen in the lower right-hand figure of the next illustration. I possess a number of obsidian flakes which were intended for that purpose, but do not appear to have been used.

The second figure from the top represents the head of a spear similarly armed, and I possess a small Australian implement in which the flakes of obsidian are set only on one side, so that the instrument can be used as a rude saw.

Between these two weapons is a spear-head armed with shark-teeth. I have a very remarkable weapon of this kind, made in Mangaia. It is eleven feet in length, and, besides being armed with a double row of sharks' teeth nearly to the handle, it has three curved blades similarly armed, set at distances of about two feet, and projecting at right angles. Thus, if the foe were missed with the point of the spear, he would probably be wounded by one of the blades.



The upper figure represents a weapon where the natural bone of the sting-ray has been used as the point.

On the opposite side are seen three natural objects similarly armed. The uppermost is another species of sword-grass, like that which has already been described.

Next comes a magnified view of one of the three cutting instruments of the leech, showing the serrated teeth set along its edge, by means of which it produces the sharply-cut wounds through which it sucks the blood.

The last figure represents the head of the common Saw-fish, in which a vast number of flat and sharply-edged teeth are set upon the blade-like head. The fish has been observed to use this weapon just as the Mangaian uses his sword-spear. It dashes among a shoal of fish, sweeps its head violently backwards and forwards, and then, after they have dispersed, picks up at its leisure the dead and disabled.

The Spear and the Dagger

It is tolerably evident that the invention of the spear and dagger must have been nearly, if not quite, contemporaneous with that of the club. I place these weapons together because there is great difficulty in assigning to either of them the precedence, the spear being but a more or less elongated dagger, and the dagger a shortened spear.

As a good example of this fact, I have in my collection a number of spears and daggers belonging to the Fan tribe of Western Africa. In every case the weapons correspond so closely with each other, that if the daggers were attached to shafts they would exactly resemble the spears, and if the spears were cut off within a few inches of the head, they would be taken for daggers.

I may here mention that as this part of the subject merely involves the employment of a pointed or thrusting weapon, instead of the club or sword, both of which are used for striking, the question of poison, barbs, and sheaths will be treated on another page.

The primary origin of the Spear is probably the thorn, as a savage who had been wounded by a thorn would easily pass to the conclusion that a thorn of larger size would enable him to kill an enemy in war, or an animal in hunting. Anything of sufficient dimensions, which either possessed a natural point or could be sharpened into a point, would be available for the purpose of the hunter or warrior.

Accordingly we find that such objects as the beak of the heron or stork, the sharp hind-claw of the kangaroo, the bone of the sting-ray, the beak of the sword-fish, and many similar objects, are employed for the heads of spears, or used simply as daggers.

As to artificial spears, nothing is easier than to scrape a stick to a point, and then, if needful, to harden it in the fire. This is, indeed, one of the commonest forms of primitive spears, and I have in my collection many examples of such weapons. Another simple form of this weapon is that which is made by cutting a stick or similar object diagonally.

Hollow rods—such, for example, as the bamboo—are the best for this purpose. I have now before me a cast of a most interesting weapon discovered by Colonel Lane Fox. It is the head of a spear, and is formed from part of the leg-bone of a sheep. At one end there is a simple round hole, which acted as a socket for the reception of the shaft, and the other end is cut away diagonally, so as to leave a tolerably sharp point.

As to the bamboo, it has a great advantage in the thinness of its walls, and the coating of flinty substance with which it is surrounded, and which gives its edges a knife-like sharpness. Indeed, so very sharp is the silex, that splinters of bamboo are still used as knives, and with them a skilful operator can cut up a large hog as expeditiously as one of our pork-butchers could do with the best knife that Sheffield produces.

I possess several of these weapons, and formidable arms of offence they are. If the reader can imagine to himself a toothpick, a foot or more in length, made from bamboo instead of quill, and having its edges nearly as sharp as a razor, he can realise the force of even so simple a weapon. In the case of the bamboo, too, celerity of manufacture has its value, for any one can make a couple of spears in less than as many minutes. All he has to do is to cut down a joint of bamboo transversely, and then with a diagonal blow of his knife at the other end to form the point.

The force of such a weapon may be inferred from a remarkable combat that took place some sixty years ago, when the roads were not so safe as they are at present.

A gentleman, who happened to be a consummate master of the sword, was going along the highway at night, and was attacked by two footpads, he having no weapon but a bamboo cane.

One of them he temporarily disabled by a severe kick, and then turned to the other, whom he found to be pretty well as good a swordsman as himself, and to possess a good stick instead of a slight cane. The footpad soon discovered the discrepancy of weapons, and with a sharp blow smashed the cane to pieces, leaving only about eighteen inches in his antagonist's hand.

Almost instinctively Baron – sprang under the man's guard, and dashed the broken cane in his face. The footpad staggered with a groan, put his hands to his face, and ran away, followed by his companion, who did not desire another encounter with such an antagonist. When the victor reached his destination, he found that the footpad's face must have been torn to pieces, for the clefts of the split bamboo were full of scraps of skin, flesh, and whisker hair.

It is worthy of notice that the combination of the club and the dagger is common to savage and civilised life, as may be seen by reference to the illustration in page 53, where the wooden club of savage warfare and the metal club and maces of civilisation are alike armed with a piercing as well as a bruising apparatus. Mostly the dagger is on the head of the mace or battle-axe, but, in some cases, the end of the handle acts as the dagger, and the head as the axe or mace.

A very good example of this formation is found in the wooden battle-axe, or "Pato," of New Zealand, a weapon which has been long superseded by modern fire-arms. A specimen in my possession is rather more than five feet in length. The head is just like that of an ordinary axe, while the handle tapers gradually to the end, where it terminates in a sharp spike. In actual combat the point was used much more than the axe.

CHAPTER II.

POISON, ANIMAL AND VEGETABLE.

—PRINCIPLE OF THE BARB

Poison as applied to Weapons.—Its limited Use.—Animal and Vegetable Poisons.—Animal Poisons.—The Malayan Dagger, or Kris, and two Modes of poisoning it.—The Bosjesmans and their Arrows.—Snake Poison and its Preparation.—The Pseudo-barb.—The Poison-grub, or N'gwa.—Simple Mode of Preparation, and its terrible Effects.—Vegetable Poisons.—The Upas of Malacca.—The Wourali Poison of Tropical America.—Mode of preparing the various Arrows.—The Fan Tribe of West Africa, and their poisoned Arrows.—Subcutaneous Injection.—Examples in Nature.—The Poison-fang of the Serpent.—Sting of the Bee.—Tail of the Scorpion.—Fang of the Spider.—Sting of the Nettle.—Exotic Nettles and their Effects.—The Barb and its Developments.—The “Bunday” of Java.—Reversed Barbs of Western Africa.—Tongans and their Spears.—The Harpoon and Lernentoma, or Sprat-sucker.—The Main Gauche, or Brise-épée.

ANOTHER advance, if it may so be called, lay in increasing the deadly effect of the weapons by arming them with poison.

Without the poison, it was necessary to inflict wounds which in themselves were mortal; but with it a comparatively slight wound would suffice for death, providing only that the poison mixes with the blood. It is worthy of notice that cutting weapons, such as swords and axes, seldom, if ever, have been envenomed, the poison being reserved for piercing weapons, such as the dagger, the spear, and the arrow.

Animal Poisons

Perhaps the most diabolical invention of this kind was the Venetian stiletto, made of glass. It came to a very sharp point, and was hollow, the tube containing a liquid poison. When the dagger was used, it was driven into the body of the victim, and then snapped off in the wound, so that the poison was able to have its full effect.

Such poisons are of different kinds, and invariably animal or vegetable in their origin. Taking the animal poisons first, we come to the curious mode of poisoning the Malayan dagger, or “Kris.” The blade of the weapon is not smooth, but is forged from very fibrous steel, and then laid in strong acid until it is covered with multitudinous grooves, some of them being often so deep that the acid has eaten its way completely through the blade.

Among some tribes the kris is poisoned by being thrust into a putrefying human body, and allowed to remain there until the grooves are filled with the decaying matter. It is also said that if the kris be similarly plunged into the thick stem that grows just at the base of the pine-apple, the result is nearly the same.

As a rule, however, the Arrow is generally the weapon which is poisoned, and a few examples will be mentioned of each kind of poisoning.

The two most formidable animal poisons are those which are made by the Bosjesmans of Southern Africa. Their bows are but toys, and their arrows only slender reeds. But they arm these apparently insignificant weapons with poison so potent, that even the brave and bellicose Kafir warrior does not like to fight a Bosjesman, though he be protected by his enormous shield.

There are two kinds of animal poison used by the Bosjesmans. The first is made from the secretion of the poison-glands of the cobra, puff-adder, and cerastes. Knowing the sluggish nature of snakes in general, the Bosjesman kills them in a very simple manner. He steals cautiously towards the serpent, boldly sets his foot upon its neck, and cuts off its head. The body makes a dainty feast for him, and the head is soon opened, and the poison-glands removed.

By itself, the poison would not adhere to the point of the weapon, and so it is mixed with the gummy juice of certain euphorbias, until it attains a pitch-like consistency. It is then laid thickly upon the bone point of the arrow, and a little strip of quill is stuck into it like a barb. The object of the quill is, that if a man, or even an animal, be wounded, and the arrow torn away, the quill remains in the wound, retaining sufficient poison to insure death. I have a quiverful of such arrows in my collection.

That arrows so armed should be very terrible weapons is easily to be imagined, but there is another kind of poison which is even more to be dreaded. This is procured from the innocent-looking, but most venomous, Poison-grub. It is called N'gwa by the Bosjesmans, and is the larval state of a small beetle. When the arrow is to be poisoned, the grub is broken in half, and the juices squeezed upon the arrow in small spots.

Both Livingstone and Baines give full and graphic accounts of the horrible effect produced by this dread poison, which, as soon as it mixes with the blood, drives the victim into raging madness. A lion wounded by one of these arrows has been known nearly to tear himself to pieces in his agonies. M. Baines was good enough to present me with the N'gwa grub in its different stages, together with an arrow which has been poisoned with its juices.

The Bosjesmans are themselves so afraid of the weapon, that they always carry the arrows with the points reversed, the poisoned end being thrust into the hollow reed which forms the shaft of the arrow. Not until the arrow is to be discharged does its owner place the tip with its point uncovered.

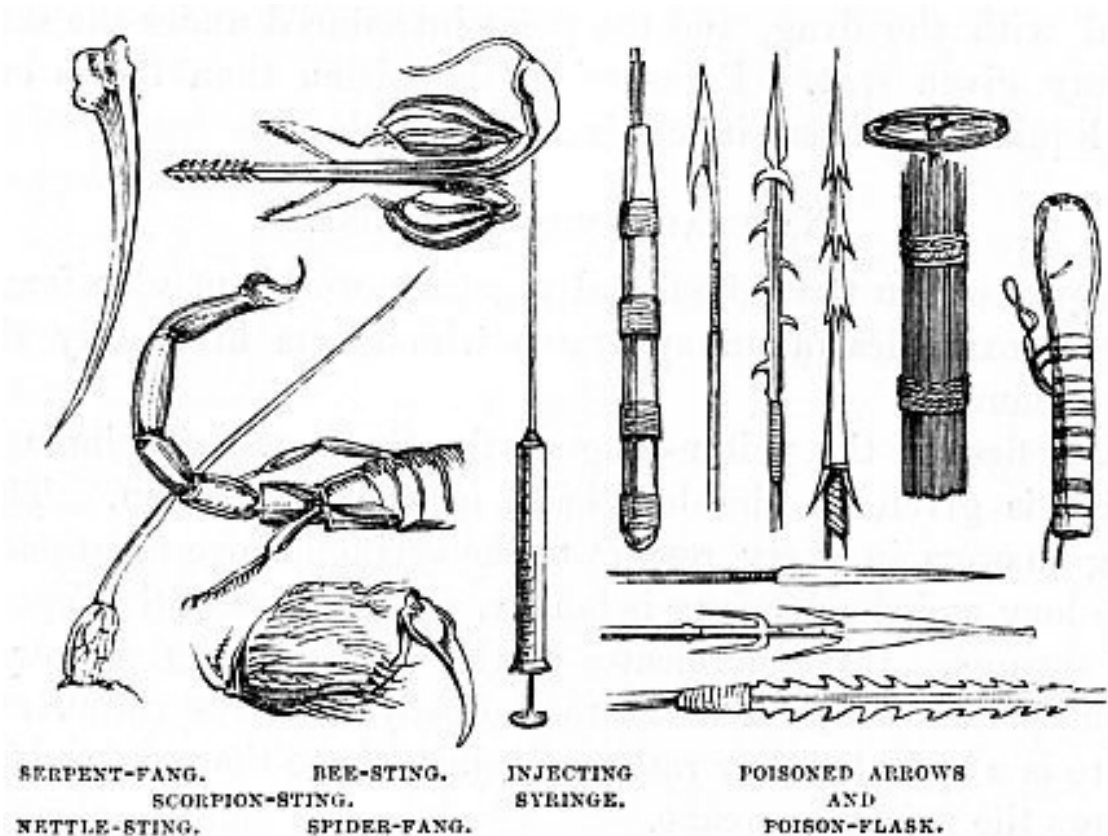
Vegetable Poisons

We now come to the Vegetable Poisons, the two best known of which are the Upas poison of Borneo, and the Wourali of South America. It is rather remarkable that in both these cases the arrows are very small, and are blown through a hollow tube, after the manner of the well-known "Puff-and-dart" toy of the present day.

The Upas poison is simply the juice of the tree, and it does not retain its strength for more than a few hours after it has been placed on the arrow-points. A supply of the same liquid is therefore kept in an air-tight vessel made of bamboo, the opening being closed by a large lump of wax kneaded over it at the mouth. One of these little flasks, taken from a specimen in my collection, is seen on the extreme right of the illustration.

The Wourali poison owes all its power to its vegetable element, though certain animal substances are generally mixed with it. The principal ingredient is the juice of one of the strychnine vines, which is extracted by boiling, and then carefully inspissated until it is about the consistency of treacle. This poison differs from the Upas in the fact that it retains its potency after very many years, if only kept dry. I have a number of arrows poisoned with the Wourali. They were given to me by the late Mr. Waterton, who procured them in 1812, and even in the present year (1875) they are as deadly as when they were first made.

A bundle of these tiny arrows, surmounted by the little wheel which is used to guard the hand from being pricked, is seen next to the Bornean poison-flask.



Beside these little arrows, which are only about ten inches in length, very much larger arrows are used both for war and hunting, and are propelled by the bow, and not with the breath. Many of these arrows are nearly six feet in length. In all, the head is movable fitting quite loosely into a socket, so that when an animal is struck and springs forward, the shaft is shaken off, to be picked up by the hunter, and fitted with another point, while the poisoned head remains in the wound.

Another kind of poison, also of a vegetable origin, is used by the Fan tribe. The arrows are mere little slips of bamboo, and are propelled by a slight crossbow. But the poison is so potent, that even these tiny weapons produce a fatal effect.

Nearly in the centre of the illustration is seen a rather curiously formed syringe, with an extremely long and slender tip. This is a recently invented instrument, used for the purpose of subcutaneous injection—*i.e.* of injecting any liquid under the skin. It is mostly employed for injecting opium and other drugs of similar qualities, for the purpose of obtaining relief from local pain. The slender spike-like point is hollow, and ends in a sharp tip, formed like the head of a lance. Just below the head there is a little hole, communicating with the interior of the tube.

The mode of operating is simple enough. The syringe is filled with the drug, and the point introduced under the skin at any given spot. Pressure on the piston then forces out the liquid, and causes it to mix with the blood.

Natural Animal Poisons

Now, both in the animal and vegetable worlds may be found several examples of an apparatus which acts in exactly the same manner.

The first is the poison-fang of the Serpent, a specimen of which is given on the left hand of the illustration. This fang answers in every respect to the syringe above mentioned. The long and slender fang is hollow, and answers to the pipe of the syringe. It communicates at the base with a reservoir

of liquid poison, which answers to the body of the syringe, and there is a little hole, or rather slit, just above the point, which allows the poison to escape.

When the serpent makes its stroke, the base of the fang is driven against the reservoir, so that the liquid is urged through the hollow tube, and forced into the wound. Even in large serpents these fangs are very small. I have now before me some fangs of the cobra, puff-adder, rattlesnake, and viper, and it is astonishing how small and slender are these most deadly weapons. The figure in the illustration is much magnified, in order to show the aperture at the base, where communication is made with the interior of the fang. As the exit hole is on the upper curve of the fang, it is not visible in the figure.

Next to the serpent's fang is a representation of the Bee-sting, the poisonous reservoir being seen at the base, and having attached to it the tiny thread-like gland by which the poison is secreted.

In the centre is seen the tail of a Scorpion, with its hooked sting. The last joint is formed just like the serpent's fang, being hollow, having a sharp point with a slit near the end, and a poison reservoir in the rounded base. When the scorpion attacks an enemy, it strikes violently with the tail, and the force of the blow drives out the poison just as is done with the serpent's fang.

At the bottom of the illustration is shown the poison-fang of a Spider, which, as the reader may see, is formed just on the principle of the scorpion-sting.

Natural Vegetable Poisons

So much for animal poisons. We will now pass to the vegetable world.

Of the vegetable sting-bearers none are more familiar to us than the Nettle, three species of which inhabit this country. The two commonest are the Great Nettle (*Urtica dioëcea*) and the Small Nettle (*Urtica urens*), and both of them are armed with venomous stings, which cause the plants to be so much dreaded.

The structure of these stings is very simple, and can be made out with an ordinary microscope, or even a good pocket lens. Each of these stings is, in fact, a rather elaborately constructed hair, hollow throughout its length, coming to a point at the tip, and having the base swollen into a receptacle containing the poisonous juice. When any object—such, for example, as the human hand—touches a nettle, the points of the stings slightly penetrate the skin, and the hair is pressed downwards against the base, so that the poison is forced through the hole.

One of these hairs is shown in the left-hand bottom corner of the illustration.

Even the tiny stings of our English nettles are sufficiently venomous to cause considerable pain, and, in some cases, even to affect the whole nervous system. But some of the exotic nettles are infinitely more formidable, and are, indeed, so dangerous that, when they are grown in a botanical garden, a fence is placed round them, so as to prevent visitors even from touching a single leaf.

The two most dreaded species are called *Urtica heterophylla* and *Urtica crenulata*. The former is thought to be the more dangerous of the two, and a good idea of its venomous qualities may be gathered from an account of an adventure with *Urtica crenulata*. The narrator is M. L. de la Tour.

“One of the leaves slightly touched the first three fingers of my left hand; at the time I only perceived a slight pricking, to which I paid no attention. This was at seven in the morning. The pain continued to increase, and in an hour it became intolerable; it seemed as if some one were rubbing my fingers with a hot iron. Nevertheless, there was no remarkable appearance, neither swelling, nor pustules, nor inflammation.

“The pain spread rapidly along the arm as far as the armpit. I was then seized with frequent sneezing, and with a copious running at the nose, as if I had caught a violent cold in the head. About noon I experienced a painful attack of cramp at the back of the jaws, which made me fear an attack of tetanus. I then went to bed, hoping that repose would alleviate my suffering, but it did not abate. On the contrary, it continued nearly the whole of the following night; but I lost the contraction of the jaws about seven in the evening.

“The next morning the pain began to leave me, and I fell asleep. I continued to suffer for two days, and the pain returned in full force when I put my hand into water. I did not finally lose it for nine days.”

There is another of these formidable nettles, called in the East by a name which signifies “Devil’s Leaf,” and which is sufficiently venomous to cause death. There is but little doubt, however, that in the present instance, if a larger portion of the body—say the whole arm—instead of three fingers, had been stung, death would have ensued from the injury.

The Barb

We now come to another improvement, or rather addition, in the various piercing weapons. Sometimes, as in the case of the dagger or the hand-spear, it was necessary that when a blow had been struck the weapon should be easily withdrawn from the wound, so as not to disarm the assailant, and to enable him to repeat the stroke if needful. But in the case of a missile weapon, such as a javelin or an arrow, it was often useful, both in war and hunting, to form the head in such a way that when it had once entered it could scarcely be withdrawn. For this purpose the Barb was invented, taking different forms, according to the object of the weapon and the nationality of the maker.

As in this work I prefer to show the gradual development of human inventions, I shall take my examples of barbs entirely from the weapons of uncivilised nations, six examples of which are given in the accompanying illustration, and five of them being drawn from specimens in my collection.



The upper left-hand figure is rather a curious one, the position of the barbs being nearly reversed, so that they serve to tear the flesh rather than adhere to it. The opposite figure represents an arrow with a doubly barbed point. It is chiefly used for shooting fish as they lie dozing on or near the surface of the water, but it is an effective weapon for ordinary hunting purposes, and, as the shaft is fully five feet in length, is quite formidable enough for war.

The left-hand bottom figure represents a very remarkable instrument, for it can hardly be called a weapon, and is, in fact, the head of a policeman’s staff. It is peculiar to Java, and is called by the name of “Bunday.” As may be seen by reference to the illustration, the head of the Bunday is formed of two diverging slips of wood. To each of these is lashed a row of long and sharp thorns, all pointing inwards, and the whole is attached to a tolerably long shaft.

When a prisoner is brought before the chief, a policeman stands behind him, armed with the Bunday, and, if the man should try to escape, he is immediately arrested by thrusting the weapon at him, so as to catch him by the waist, neck, or arm, or a leg. Escape is impossible, especially as in Java the prisoner wears nothing but his waist-cloth.

A weapon formed on exactly the same principle was used in the fifteenth and sixteenth centuries, and was employed for dragging knights off their horses. It was of steel instead of wood, and the place of the thorns was taken by two movable barbs, working on hinges, and kept open by springs. When a thrust was made at the knight's neck the barbs gave way, so as to allow the prongs to envelop the throat, and they then sprang back again, preventing the horseman from disengaging himself. This weapon is technically named a "catchpoll."

An illustration of one of these weapons will be given on another page.

The right-hand central figure is an arrow from Western Africa. In a previous illustration (page 65) a head of one of these arrows is given on rather a larger scale, so as to show the very peculiar barbs. These are of such a nature that when they have well sunk into the body they cannot be withdrawn, but must be pushed through, and drawn out on the opposite side. This is drawn from one of my own specimens.

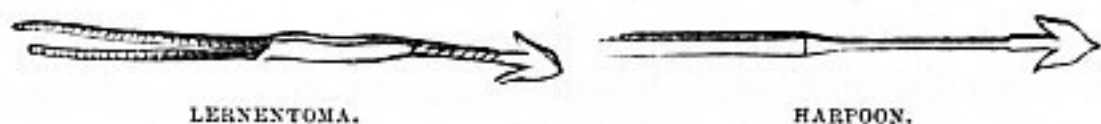
In some cases, with an almost diabolical ingenuity, the native arrow-maker has set on a couple of similar barbs, directed towards the point, so that the weapon can neither be pushed through nor drawn back. One of these arrows is shown in the illustration, but, for want of space, the artist has placed the opposing barbs too near each other.

In some parts of Southern Africa a similar weapon was used for securing a prisoner, the barbed point being thrust down his throat and left there. If it were pushed through the neck it killed him on the spot, and if it remained in the wound the man could not eat nor drink, and the best thing for him was to die as soon as he could.

With similar ingenuity, the Tongans and Samoans made their war-spears with eight or nine barbs, and, before going into action, used to cut the wood almost through between each barb, so that when the body was pierced, the head, with several of the barbs, was sure to break off and leave a large portion in the wound. In Mariner's well-known book there is an admirable account of the mode employed by a native surgeon for extracting one of these spear-heads. So common was this weapon that every Tongan gentleman carried a many-barbed spear about five feet long, and used it either as a walking-stick or a weapon. It is needless to say that this spear is almost an exact copy of the tail-bone of the Stingray. A dagger made of this bone was used in the Pelew Islands in 1780, but seemed to be rather scarce.

The left-hand central figure is a Fijian fish-spear of four points, and the last figure on the right hand represents a large four-pronged spear of Borneo. Both these weapons are in my collection.

Another example of a weapon where a large and powerful barb is needful is the Harpoon. As the harpoon is used in capturing the whale, the largest and most powerful of living mammalia, it is evident that a barb which will hold such a prey must be rather peculiarly made. The head and part of the shaft of the harpoon are shown in the right-hand figure of the accompanying illustration.



The left-hand figure represents a curious parasitic crustacean, popularly called the Sprat-sucker, because it is usually found on sprats. It affixes itself mostly to the eye, the deeply barbed head being introduced between the eye and the socket. In some seasons this remarkable parasite is quite plentiful, while in others scarcely a specimen can be found. Its total length is slightly under an inch, and its scientific name is *Lernentoma Spratti*.

The following graphic account of some prototypic weapons belonging to a marine worm is given by Mr. Rymer Jones, and is well worthy of perusal, not only for the vividness of the description, but for its exact accuracy:—

“Here is a Polynoe, a curious genus, very common under stones at low water on our rocky shores.

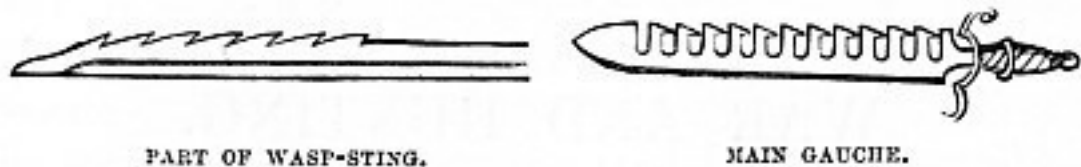
“It is remarkable on several accounts. All down the back we discover a set of oval or kidney-shaped plates, which are called the back-plates (*dorsal elytra*); these are flat, and are planted upon the back by little footstalks, set on near the margin of the under surface: they are arranged in two rows, overlapping each other at the edge. These kidney-shaped shields, which can be detached with slight violence, are studded over with little transparent oval bodies, set on short footstalks, which are, perhaps, delicate organs of touch. The intermediate antennæ, the tentacles, and the cirrhi or filaments of the feet, are similarly fringed with these little appendages, which resemble the glands of certain plants, and have a most singular appearance.

“If we remove the shields, we discover, on each side of the body, a row of wart-like feet, from each of which project two bundles of spines of exquisite structure. The bundles, expanding on all sides, resemble so many sheaves of wheat, or you may more appropriately fancy you behold the armoury of some belligerent sea-fairy, with stacks of arms enough to accoutre a numerous host.

“But, if you look closely at the weapons themselves, they rather resemble those which we are accustomed to wonder at in missionary museums,—the arms of some ingenious but barbarous people from the South Sea Islands,—than such as are used in civilised warfare. Here are long lances, made like scythe-blades, set on a staff, with a hook on the tip, as if to capture the fleeing foe, and bring him within reach of the blade. Among them are others of similar shape, but with the edge cut into delicate slanting notches, which run along the sides of the blade like those on the edge of our reaping-hooks.

“These are chiefly the weapons of the lower bundle; those of the upper are still more imposing. The outermost are short curved clubs, armed with a row of shark’s teeth to make them more fatal; these surround a cluster of spears, the long heads of which are furnished with a double row of the same appendages, and lengthened scimitars, the curved edges of which are cut into teeth like a saw.

“Though a stranger might think I had drawn copiously on my fancy for this description, I am sure, with your eye upon what is on the stage of the microscope at this moment, you will acknowledge that the resemblances are not at all forced or unnatural. To add to the effect, imagine that all these weapons are forged out of the clearest glass instead of steel; that the larger bundles may contain about fifty, and the smaller half as many each; that there are four bundles upon every segment, and that the body is composed of twenty-five such segments, and you will have a tolerable idea of the garniture and armature of this little worm, which grubs about in the mud at low-water mark.”



Somewhere between the fifteenth and sixteenth centuries a sort of anomalous weapon was in use, namely, a dagger, with a number of very deep and bold barbs. It was not, however, employed for offence, but for defence, and was used in the “rapier and dagger” mode of fighting, when the dagger, which was held in the left hand, was employed to parry the thrusts of the rapier, which was held in the right. From the mode of holding it, the weapon was called “Main Gauche.”

Sometimes the blade was quite plain, and, indeed, an ordinary dagger answered the purpose. But in most cases the Main Gauche was made for this special purpose, and was furnished either with strong diverging projections, or with a series of deep notches, so that the sword of the enemy might

be caught in them and broken. In consequence of this use these notched or guarded weapons were also called by the name of *Brise-épée*, or Sword-breaker.

The resemblance between this weapon and the blade of a wasp's sting can be seen at a glance. There is another form of the *Brise-épée* which is so strangely like the cutting apparatus of one of the saw-flies, that an outline sketch of the one would answer very well for the other.

CHAPTER III. PROJECTILE WEAPONS AND THE SHEATH

Propulsive Power.—The Pea-shooter and its Powers.—An Attack repulsed.—Clay Bullets.—Puff and Dart.—The Sumpitan of Borneo, and its Arrows.—The Zarabatana or Pucunha of South America, and its Arrows.—The Air-gun.—Modern Firearms.—The Chætodon, or Archer-fish.—The Pneumatic Railway.—The Throwing-stick and its Powers.—Australians, Esquimaux, and New Caledonians.—Principle of the Sheath.—Waganda Spears.—Sheathed Piercing Apparatus of the Gnat, Flea, and Bombylius.—Indian Tulwar and Cat's Claw.—The Surgeon's Lancet, and Piercing Apparatus of the Gad-fly and Mosquito.

WE will now take some of the analogies between Projectile Weapons of Art and Nature, selecting those in which the propulsive power is air or gases within a tube. Whether the weapon be a blow-gun, an air-gun, or a firearm of any description, the principle is the same. We will take them in succession, choosing first those of the simplest and most primitive character.

Taking ourselves as examples, and looking upon the toys of children as precursors of more important inventions, we find that the simplest and most primitive of projectiles is the Pea-shooter, so familiar to all boys.

Insignificant as is the little tin tube, and small as are the missiles which are propelled through it, the blow which can be struck by a pea properly shot is no trifle. At college I have seen a night attack upon an undergraduate's rooms successfully repelled by a pea-shooter made for the nonce of a glass tube, the owner of the rooms having a taste for chemicals, and possessing a fair stock of the usual apparatus. Though the assaulted rooms were on the top set, and the assailants began their storming approaches below, the peas were too much for the stones, taking stinging effect on the hands and faces, and preventing any good aim being taken at the windows. Only two panes of glass were broken through a siege that lasted for several hours.

There is another toy which is a development of the pea-shooter, and carries a small clay bullet instead of a pea. When the tube is quite straight and the balls fit well, the force of this missile is very great, as it can be used for killing small birds. Indeed, such an instrument is largely employed by the native hunters in procuring humming-birds for the European market. These weapons are generally lined with metal in this country, but a simple bamboo tube is sufficient for the native hunters.

A still further improvement occurs where the place of the bullet is taken by a small dart or arrow, which is usually made to fit the bore by having a tuft of wool, or some similar substance, at the butt. The arrow is aimed at a target, and the toy is popularly known as "Puff and Dart."

With us this apparatus is only a toy, but in several parts of the world it becomes a deadly weapon, namely, in Borneo and over a large part of tropical America. In both cases the arrows are poisoned, as has already been mentioned when treating of poisoned weapons.

The first and best known of these weapons is the dreaded Sumpitan, or Blow-gun, of Borneo, the arrows of which are poisoned with the deadly juice of the upas-tree. Here I may as well mention that the scientific name of the upas-tree is *Antiaris toxicaria*. It belongs to a large group of plants, all of which have an abundance of milk-like and sometimes poisonous juice. We are most of us familiar with the old story of the upas-tree and its deadly power, and how the tree stood in a valley, in which nothing else could live, and that condemned criminals might compound for their inevitable fate by venturing into the valley of death and bringing back a flask of the dread poison. Even birds were supposed to be unable to fly over the valley, but to fall into it, being poisoned by the exhalations of the tree.

Now, there is a saying that there is no smoke without fire, and though this account is evidently incredible, it is not altogether without foundation. In Java, as in many other parts of the world, there are low-lying places where carbonic acid gas exudes from the earth, and no living creature can exist in them. Even in this country scarcely a year passes without several deaths occurring from inhalation of the same fatal gas, which has collected in some disused excavation. That there is, therefore, a deadly valley in Java may be true enough, and it is also true that the juice of the upas-tree is poisonous when it mixes with the blood. But the two have no connection with each other, and, so far from the upas-tree poisoning the valley by its exhalations, it could not exist in such an atmosphere.

Now for the Sumpitan and the arrows. The former is a tube, some seven feet in length, with a bore of about half an inch in diameter, and often elaborately inlaid with metal. I have one in which the whole of the mouthpiece is brass, and the other end of the weapon has been fitted with a large spear-head, exactly on the principle of the bayonet.

The arrows are very slight, and, in order to make them fit the tube, are furnished at their bases with a conical piece of soft wood. In themselves they would be almost useless as weapons, but when the poison with which their points are armed is fresh, these tiny arrows, of which sixty or seventy are but an ordinary handful, carry death in their points. Though they have no great range, they are projected with much force, and with such rapidity that they cannot be avoided, their slender shafts being almost invisible as they pass through the air.

The second weapon is the still more dangerous blow-gun of tropical America, called Zarabatana, or Pucunha, according to the locality. Some of these tubes measure more than eleven feet in length, and through them the arrow can be propelled with wonderful force. I have often sent an arrow to a distance of a hundred yards, and with a good aim.

A native, however, can send it much farther, knack, and not mere capacity of lung, supplying the propelling power, just as it is with the pea-shooter. When the arrow is properly blown through the zarabatana a sharp “pop” ought to be heard, like the sound produced by a finger forced into a thimble and quickly withdrawn, or a cork drawn from a bottle.

As to seeing the diminutive arrow in its flight, it is out of the question, and no agility can be of the least use in avoiding it. One of my friends, a peculiarly sharp-sighted officer of artillery, has often tested this point, and although there was but one arrow to watch, and it was blown in the open air, he could not see it until it either struck or passed him (of course the poisoned end was cut off). What, then, would be the result of a number of these deadly missiles hurled out of a dense bush may easily be imagined.

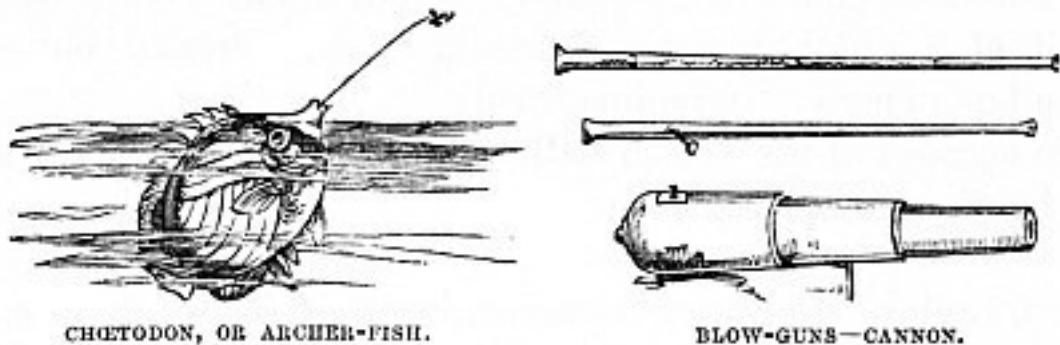
An account of the poison with which these arrows are armed will be found on p. 64.

The reader will please to remember that in all these cases the missile is propelled by air which is compressed by the aid of the lungs, and forced into the tube behind the bullet or arrow. Now, the Air-gun, which really can be made a formidable weapon, is constructed on exactly the same principle as the pea-shooter and the blow-guns, except that the air is compressed by the human arm instead of the human lungs. There are various modifications of this weapon, but in all of them air is driven into a strong chamber by means of a forcing syringe, and is released by the pull of the trigger, so as to drive out the missile which has been placed in the barrel.

It is worthy of notice that the term “noiselessly destructive” weapon, as applied to the air-gun, is entirely false. I have already mentioned that with the blow-gun of tropical America a definite explosion accompanies the flight of each arrow. The same result occurs with the air-gun, the loudness of the report being in exact proportion to the force of the air, each successive report becoming slighter and the propulsive power weaker until a new supply of air is forced into the chamber.

However dissimilar in appearance may be the cannon, rifle, pistol, or any other firearm, to the pea-shooter and its kin, the principle is exactly the same in all. It has been already mentioned that in the blow-guns the air is compressed by the exertion of human lungs, and in the air-gun the compression is achieved by human hands.

But with the firearm a vast volume of expansible gas is kept locked up in the form of gunpowder, gun-cotton, fulminating silver, or other explosive compound, and is let loose, when wanted, by the aid of fire.



In the illustration are represented on the right hand the blow-guns of America and Borneo, and below them is the cannon as at present made. On the left hand of the same illustration is seen a representation of a natural gun which has existed for thousands of years before gunpowder was invented, and very long before the savage of Borneo or America discovered the blow-gun.

It is the Archer-fish (*Chaetodon*), which possesses the curious power of feeding itself by shooting drops of water at flies, and very seldom failing to secure its prey.

There are several species of this very curious fish spread over the warmer parts of the world, and their remarkable mode of obtaining prey is very well known in all. There is, indeed, scarcely any phenomenon in Nature more remarkable than the fact of a fish being able to shoot a fly with a drop of water projected through its tubular beak, if we may use that expression for so curiously modified a mouth.

Indeed, so certain is the fish of its aim, that in Japan it is kept as a pet in glass vases, just as we keep gold fish in England, and is fed by holding flies or other insects to it on the end of a rod a few inches above the surface of the water. The fish is sure to see the insect, and equally sure to bring it down with a drop of water propelled through its beak.

It is worthy of remark that the same principle was once, though unsuccessfully, employed in the propulsion of carriages, under the name of the Pneumatic Railway. Some of my readers may remember the railway itself, or at all events the disused tubes which lay for so many years along the Croydon Railway. Speed was obtained, as I can testify from personal experience, but the expense of air-pumps and air-tight tubing was too great to be covered by the income, especially as the rats ate the oiled leather which covered the valves.

I find some little difficulty in arranging the subject which comes next in order. It might very properly be ranked among the Levers, which will be treated of in another chapter; or it might be placed among the examples of centrifugal force, together with the sling, the “governor” of the steam-engine, &c., all of which will be more fully described in their places. However, as we are on the subject of Projectiles, we may as well take it in the present place.

It is the Throwing-stick, by which the power of the human arm is enormously increased, when a spear is to be hurled. Perhaps the most expert spear-throwers in the world are to be found among the Kafir tribes of Southern Africa, and yet the most experienced among them could not make sure of hitting a man at any distance above thirty or forty yards. But the throwing-stick gives nearly double the range, and I have seen the comparatively slight and feeble Australian hurl a spear to a distance of a hundred yards, and with an aim as perfect as that of a Kafir at one-fourth of the distance.

The mode in which this feat is performed is shown in the accompanying diagram. Instead of holding the spear itself, the native furnishes himself with a “Throwing-stick.” This weapon varies

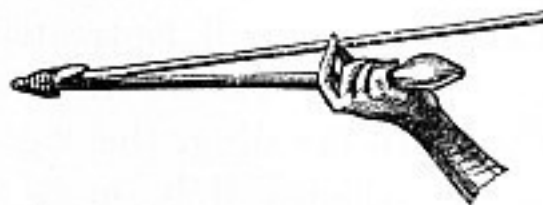
greatly in shape and size, but a very good idea of its form, and the manner of using it, may be obtained from the accompanying illustration, which was drawn from the actual specimen as held by an Australian native.

The throwing-stick is armed at the tip with a short spike, which fits into a little hole in the but of the spear. The stick and spear being then held as shown in the illustration, it is evident that a powerful leverage is obtained, varying according to the length of the stick. I possess several of these instruments, no two of which are alike.

It is rather remarkable that among the Esquimaux a throwing-stick is also used, exactly similar in principle, but differing slightly in structure, the but of the spear fitting into a hole at the end of the throwing-stick. Wood being scarce among the Esquimaux, these instruments are mostly made of bone. I possess one, however, which is made of wood, beautifully polished, and adorned with a large blue stone, something like a turquoise, set almost in its middle. One of the most curious points in the formation of the Esquimaux weapon is, that the but is grooved and channelled so as to admit the fingers and thumb of the right hand. The average length of this instrument is twenty inches.



JAW OF SNAKE.



THROWING-STICK.



PIERCING APPARATUS AND SHEATHS.
GNAT.



FLEA.



BOMBYLIUS.



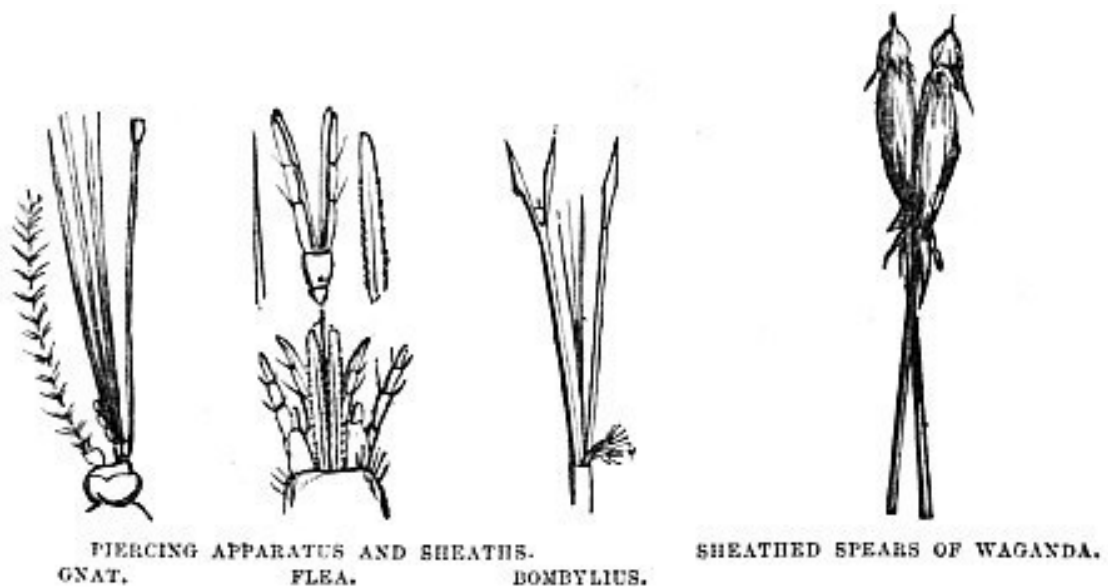
SHEATHED SPEARS OF WAGANDA.

In New Caledonia the natives use a contrivance for increasing the power of the spear, which is based on exactly identical principles, though the mode of carrying them out is different. A thong or cord of some eighteen inches in length is kept in the right hand, one end being looped over the forefinger, and the other, which is terminated by a button, being twisted round the shaft of the spear. When the weapon is thrown, the additional leverage gives it great power; and it is a noteworthy

fact that the sling-spear of New Caledonia has enabled us to understand the otherwise unintelligible “amentum” of the ancient classic writers.

Passing from Art to Nature, we have in the jaw of the serpent an exact type of the peculiar leverage by which the spear is thrown. If the reader will refer to the illustration, he will see that the lower jaw of the snake, instead of being set directly on the upper jaw, is attached to an elongated bone, which gives the additional leverage which is needful in the act of swallowing prey, after the manner of serpents.

In War and in Peace we have been long accustomed to shield the edges and points of our sharp weapons with sheaths, and even the very savages have been driven to this device. I have in my collection a number of sheathed weapons from nearly all parts of the world, and it is a remarkable fact that the Fan tribe, who are themselves absolutely naked, sheathe their daggers and axes as carefully as we sheathe our swords and bayonets. In some points, indeed, they go beyond us; for the most ignorant Fan savage would never think of blunting the edge of his weapon by sheathing it in a metal scabbard. Their sheaths are beautifully made of two flat pieces of wood, just sufficiently hollowed to allow the blade to lie between them, and bound together with various substances. For example, the sheaths of one or two daggers in my possession are made of wood covered with snake-skin, while others are simply wood bound with a sort of rattan. Even the curious missile-axe which the Fan warrior uses with such power is covered with a sheath when not in actual use.



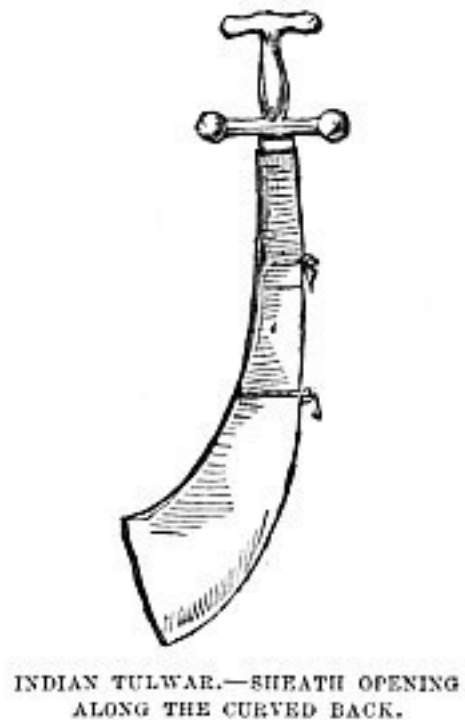
The figure on the right hand of the illustration represents the heads of two spears of Waganda warriors. When they present themselves before their king, the warriors must not appear without their weapons, and it would be contrary to all etiquette to show a bare blade except in action. The sheath can be slipped off in a moment, but there it is, and any man who dared to appear before his sovereign without his weapon, or with an unsheathed spear, would lose his life on the spot, so exact is the code of etiquette among these savages.

The sheathed spears of Nature are shown in the same illustration. On the left is a side view of the piercing apparatus of the common Gnat.

In the middle is the compound piercing apparatus of the common Flea, with which we are sometimes too well acquainted, the upper figure showing the lancets and sheaths together, and the lower exhibiting them when separated.

On the right is shown the group of mouth-lancets belonging to one of the Humble-bee flies (*Bombylius*). These flies do not suck blood like the Mosquito, the Flea, and the Gad-fly, but they use

the long proboscis for sucking the sweet juices out of flowers, and in consequence it is nearly of the same form as if it were meant for sucking blood. Indeed, there are some insects which do not seem to care very much whether the juice which they suck is animal or vegetable.



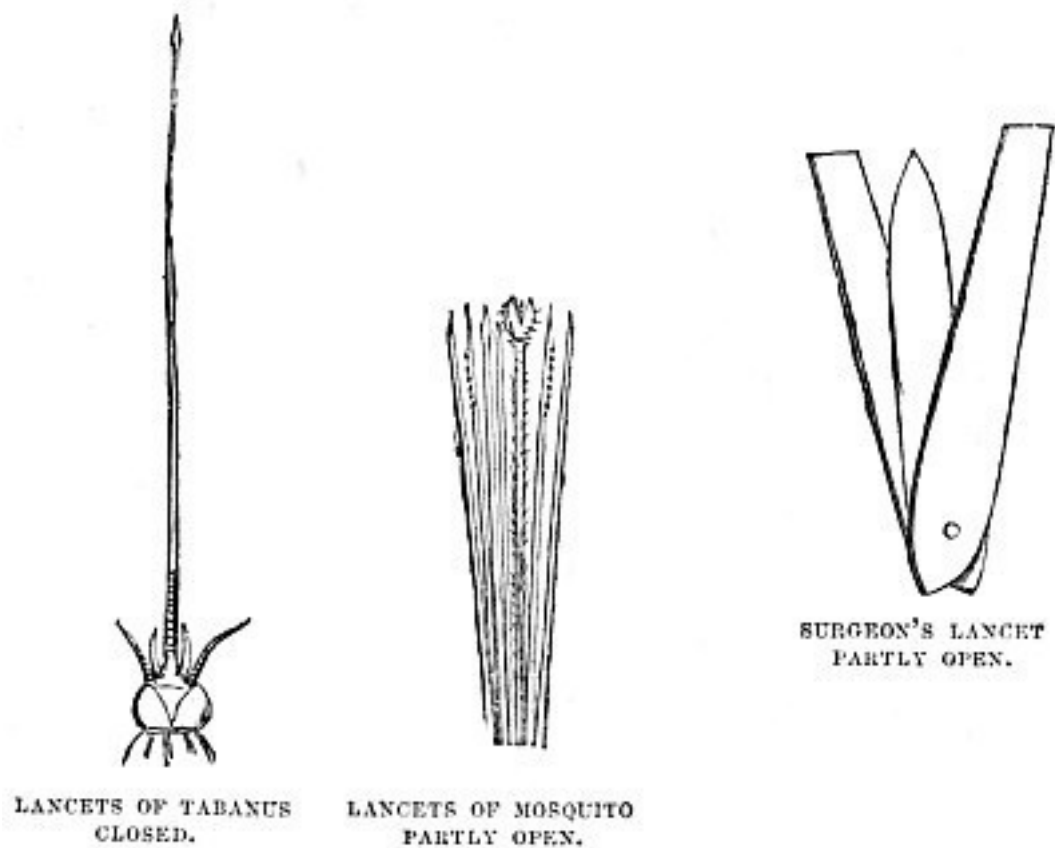
On the right hand of the illustration is seen an Indian sword, or “Tulwar,” drawn from one of my own specimens. I have selected this example on account of the structure of the sheath. It is evident, from the form of the blade, that the sword cannot be sheathed point foremost, and that therefore some other plan must be used. In this weapon the sheath is left open on one side, the two portions being held together by the straps which are shown in the figure. Of course there is loss of time in sheathing and drawing such a sword, but the peculiar shape of the blade entails a necessity for a special scabbard.

On the other side is shown one of the fore-claws of a cat, which, as we all know, can be drawn back into its simple sheath between the toes, when it is not in use. This sheath is exactly the same in principle as that of the Indian tulwar, and any one can examine it by looking at the foot of a good-tempered cat. I have done so even with a chetah, which is not a subject that would generally be chosen for such a purpose.

On the next illustration is shown an ordinary Lancet, in which the blade is guarded between a double sheath, the two halves and the blade itself working upon a common pivot. As for the ordinary sword and dagger sheaths, it is not worth while to figure them.

Turning to the opposite side of the illustration, we shall see a few of the innumerable examples in which the principle of the sheath was carried out in Nature long before man came on the earth.

The reader should compare this figure with the side view of the Gnat's lancets given on p. [81](#).



They represent the cutting and piercing instruments of several insects, all of which are very complicated, and are sheathed after the manner of the lancet. Indeed, they are popularly known as “mouth-lancets,” and with reason, as the reader may see by reference to the illustration.

On the extreme left are shown the head and closed lancets of a foreign Gad-fly, the lancets being all in their sheaths, and showing the character of the weapon which enables a small fly to be master, or rather mistress, of the forest. I say mistress, because in all these cases it is the female alone that possesses these instruments of torture.

Next it is a magnified representation of the lancets of the common Mosquito, as seen from above, both lancets being removed from their sheaths and separated.

CHAPTER IV

The Net, as used in Hunting and War.—The Seine-net, as used for Fishing.—Also as a means of Hunting.—Net for Elephant-catching.—Steel Net for Military Purposes.—Web of the Garden Spider.—The Casting-net, as used in Fishing.—Also as employed in the Combats of the ancient Circus.—Various Kinds of Casting-nets.—The Argus Star-fish and the Barnacle.—The Rod and Line.—Angling of various Kinds.—The Polynesian as an Angler.—The Angler-fish.—“Playing” a Fish.—The Nemertes and its Mode of Feeding.—Mr. Kingsley’s Account of it.—Power of Elongation and Contraction.—The Cydippe.—Spring-traps.—The Gin, Rat-trap, and Man-trap.—Jaws of Dolphin, Porpoise, and Alligator.—Legs of Phasma.—Baited Traps.—Carnivorous Plants and their Mode of Feeding.—Birdlime.—“Pegging” for Chaffinches.—Curious Mode of Tiger-killing.—Ant-eater and its Mode of Feeding.—The Drosera.—Web of Spider and its Structure.

The Net

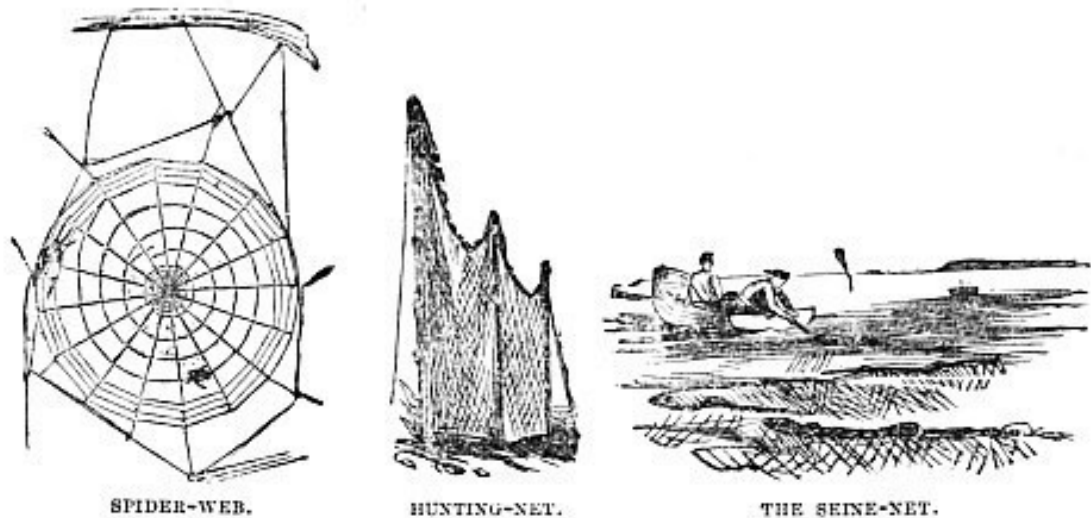
ALTHOUGH the Net is but seldom employed for the purposes of general warfare, it was once largely used in individual combats, of which we will presently treat. In hunting, however, especially in fishing, the Net has been in constant use, and is equally valued by savages and the most civilised nations.

To begin with the fisheries. Even among ourselves there are so many varieties of fishing-nets that even to enumerate them would be a work of time. However, they are all based on one of two principles, *i.e.* the nets which are set and the nets which are thrown.

We will begin with the first.

On the right hand of the illustration, and at the bottom, may be seen a common Seine-net being “shot” in the sea. This form of net is very long in proportion to its width, some of these nets being several miles long. The upper edge of the net is furnished with a series of cork bungs, which maintain it on the surface, while the lower edge has a corresponding set of weights, which keep the net extended like a wall of meshes. Any fish which come against this wall are, of course, arrested, and are generally caught by the gill-covers in their vain attempts to force themselves through the meshes.

We may see representations of fishing with the seine-net in the sculptures and paintings of Egypt and Assyria; and in the Berlin Museum there is a part of an Egyptian seine-net with the leads still upon the lower edge, and the upper edge bearing a number of large pieces of wood, which acted as buoys, and served the same purpose as our corks.



In hunting, this plan has been adopted for many centuries, the upper edge of the net being supported on poles, and the lower fastened to the ground in such a manner as to leave the net hanging in loose folds. While this part of the business is being completed by the servants, the hunters are forming a large semicircle, in which they enclose a number of wild beasts, which they drive into the nets or “toils” by gradually contracting the semicircle. The ancient sculptures give us accounts of nets used in exactly this manner. There are represented the nets rolled up ready for use, and being carried on the shoulders of several attendants, who are bearing them to the field. Then there are the nets set up on their poles, and having enclosed within them a number of wild animals, such as boars and deer.

In various parts of India, hunting with the net is one of the chief amusements of their principal men, and the variety of game driven into the toils is really surprising, and affords a magnificent sight to those who view it for the first time. Even the tiger himself cannot leap over the nets because they are so high, nor force his way through them, because their folds hang so lightly that they offer no resistance to his efforts.

A very simple net on similar principles is used for catching elephants. It is formed of the long creeping plants that fling themselves in tangled masses from tree to tree. These creepers are carefully twisted into a net-like form, without being removed from the trees, and when a sufficient space has been enclosed the elephants are driven into it. Not even their gigantic strength and tons of weight are capable of breaking through a barrier which, apparently slight, is as strong as if it were built of the tree-trunks on which the creepers are hung.

This net is seldom used for military purposes, though I have seen one, which I believe still exists, and would do good service. In one of our largest fortresses there is a subterranean corridor, through which it is desirable that the enemy should not penetrate. One mode of defence consists of a large net made of steel hanging loosely across it. The meshes are about ten inches square, so that the defenders can fire from their loopholes through the meshes, while the assailants, even if they knew of its position, would find that nothing smaller than a field-gun would have any effect on this formidable net.

The natural analogy of the fixed net is evidently the web of the common Garden Spider, or Cross Spider (*Epeira diadema*), whose beautiful nets we all must have admired, especially when we are wise enough to get up sufficiently early in the morning to see the webs with the dewdrops glittering on them.

Last year there was a wonderful sight. Within a mile of my house there is a long iron fence, which in one night had been covered with the webs of the garden spider. The following morning, though bright, was chilly, so that the dewdrops were untouched. I happened to pass by the fence soon

after sunrise, and was greatly struck with the astonishing effects which could be produced with such simple materials as water and web. The dewdrops were set at regular intervals upon the web, so as to produce a definite and beautiful pattern, the whole line of fence looking as if it had been woven in fine lace.

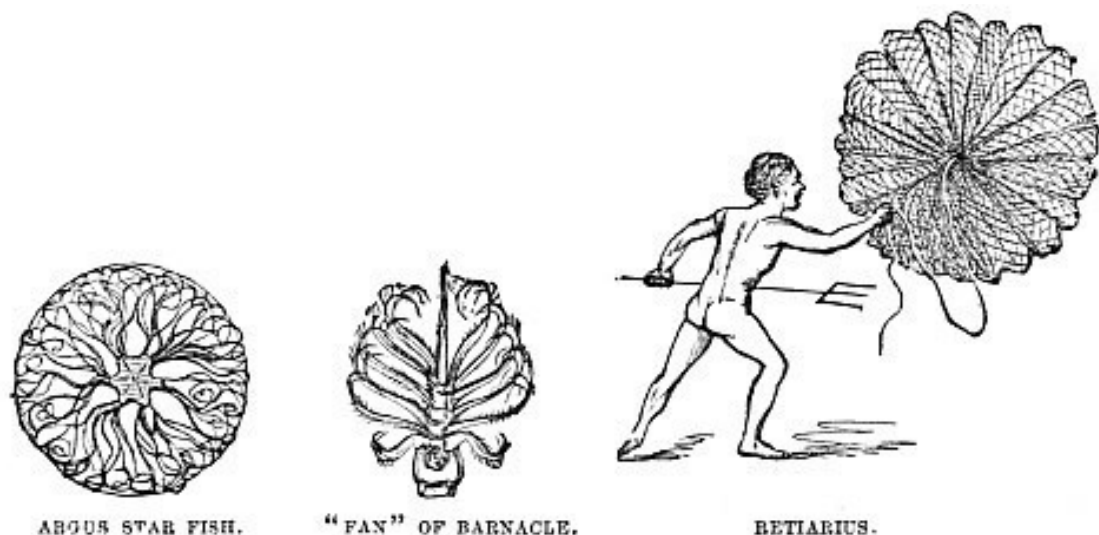
Then, as the fence runs north and south, and the path is on the westward of it, every passenger saw the rays of the rising sun dart through these tiny globules, and convert every one of them into a jewel of ever-changing colours. It seemed a pity that such beauty could but last for an hour or so, or that these exquisite webs should only be used for catching flies.

Next comes the Casting-net in its various forms. This net is mostly circular, and is loaded round the edge with small leaden plummets. It is evident that, if such a net could be laid quite flat upon the water, it would assume a dome-like shape, in consequence of the circumference being heavier than the centre, and would sink to the bottom, enclosing anything which came within its scope.

The difficulty is to place the net in such a manner, and this is accomplished by throwing it in a very peculiar way. The net is gathered in folds upon the shoulder, which it partially envelops. By a sudden jerk the thrower causes it to fly open with a sort of spinning movement, and when well cast it will fall on the water perfectly flat.

After allowing it to sink to the bottom, the fisherman draws it very gently by a cord attached to its middle. As he raises it the weights of the leaded circumference are drawn nearer and nearer together by their own weight, and finally form it into a bag, within which are all the living creatures which it has enclosed.

Though the Casting-net has never been used in warfare, it was one of the favourite implements in gladiatorial combats among the Romans. Two men were opposed to each other; one, called the Retiarius or Netsman, being quite naked, except sometimes a slight covering round the waist, and armed with nothing but a Casting-net and a slight trident, which could not inflict a deadly wound. The other, called the Secutor or Follower, from his mode of fighting, was armed with a visored helmet, a broad metal belt, and armour for the legs and arms. He also carried a shield large enough to protect the upper part of the body, and a sword. It will be seen, therefore, how great was the power of the Casting-net, when it enabled its naked bearer to face such odds of offensive and defensive armour.



When the two met in combat, the Retiarius tried to fling his net over his adversary, and if he succeeded, the fate of the latter was sealed. Entangled in the loose meshes, he could scarcely move his limbs, while the sharp prongs of the long-shafted trident came darting in at every exposed point, and exhausting the man with pain and loss of blood. The trident was in itself so feeble a weapon, that

if the Secutor were vanquished and condemned to death by the spectators, his antagonist could not kill him, but had to call another Secutor to act as executioner with his sword.

Should he fail in his cast, the Retiarius drew back his net by the central cord, and took to flight, followed by the Secutor, who tried to wound him before he could re-fold his net upon his shoulder, ready for another cast. It is worthy of notice that in these singular combats the netsman seems generally to have been the victor. A Retiarius with his net is shown in the illustration.

I may mention that our ordinary bird-catchers' nets, and even the entomologist's insect-net, are only modifications of the Casting-net.

Now for Nature's Casting-nets, two examples of which are figured, though there are many more. These two have been selected because they are familiar to all naturalists.

The first is the Argus Star-fish, Basket-urchin, or Sea-basket. The innumerable rays and their subdivisions, amounting to some eighty thousand in number, act as the meshes of the net. All the rays are flexible and under control. When the creature wishes to catch any animal for prey, it throws its tentacles over it, just like the meshes of a net. It then draws the tips of the rays together, just as is done by the circumference of the casting-net, and so encloses its prey effectually.

The next specimen is the net-like apparatus of the common Acorn Barnacles, with which our marine rocks are nearly covered. These curious beings belong to the Crustacea, and the apparatus which is figured on page [89](#), and popularly called the "fan," is, in fact, a combination of the legs and their appendages of bristles, &c. When the creature is living and covered with water, the fan is thrust out of the top of the shell, expanded as far as possible, swept through the water, closed, and then drawn back again. With these natural casting-nets the Barnacles feed themselves, for, being fixed to the rock, they could not in any other way supply themselves with food. There are many similar examples in Nature, but these will suffice.

The Rod and Line

That both terrestrial and aquatic nets should have their parallels in Nature is clear enough to all who have ever seen a spider's web, or watched the "fan" of the barnacle. But that the rod and baited line, as well as the net, should have existed in Nature long before man came on earth, is not so well known. Yet, as we shall presently see, not only is the bait represented in Nature, but even our inventions for "playing" a powerful fish are actually surpassed.

We will begin with the Bait.

In nearly all traps a bait of some kind is required, in order to attract the prey, and when we come from land to attract the dwellers in water to our hooks, it is needful that bait of some kind should be used, were it only to deceive the eye, though not the nostrils or palate, of the fish.

A notable example of the deception is given in the common artificial baits of the present day, which are made to imitate almost any British insect which a fish might be disposed to eat.

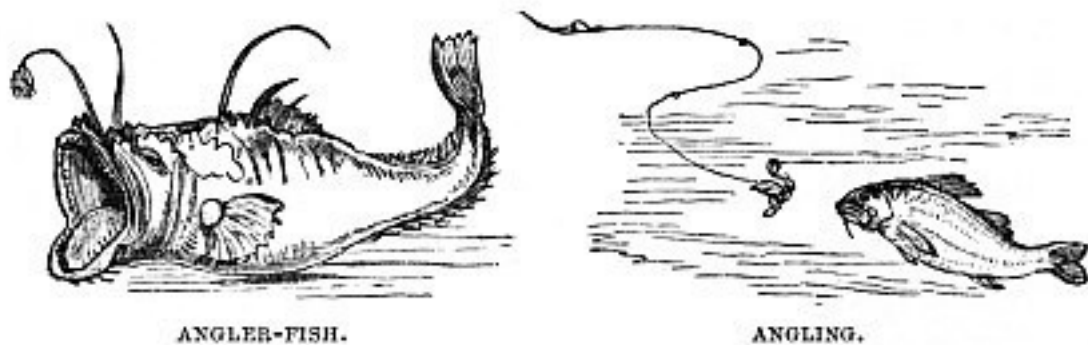
Perhaps the best instance of this deception is that which is practised by sundry Polynesian tribes. They have seen that the Coryphene or Dorado, and other similar fish, are in the habit of preying upon the flying-fish, and springing at them when they are tolerably high in the air. So these ingenious semi-savages dress up a hook made of bone, ormer-shell, and other materials, making the body of it into a rudely designed form of a fish. A hole is bored transversely through it at the shoulders, and a bunch of stiff fibres is inserted to represent the wings. Another bunch does duty for the tail.

The imitation bait being thus complete, it is hung to a long and slender bamboo rod, which projects well beyond the stern of a canoe, and is so arranged that the hook is about two feet or so from the surface. The Coryphene, seeing this object skimming along, takes it for a flying-fish, leaps at it, and is caught by the hook. There are in several collections specimens of these ingenious hooks, and I possess one which is made on similar principles, but intended for use in the water, and not in the air. It is, in fact, a "spoon-bait."

One point of ingenuity must be mentioned, as it really belongs to the principle of the bait. These same savages, having noticed that large sea-birds are in the habit of hovering over the flying-fish, and would probably be seen by the Coryphenes, rig up a very long bamboo rod, tie to its end a large bundle of leaves and fibres, and then fix it in the stern of the boat, the sham bird being hung some twenty feet above the sham fish. There is a refinement of deception here, for which we should scarcely give such savages their due credit.

In Art, then, we bait our hooks either with real or false food, and so attract the fish.

In Nature we have a most accomplished master of the art of baiting, who has the wonderful power of never needing a renewal of his bait. A glance at the left-hand figure of the next illustration will show that I allude to the Angler-fish, sometimes called the Fishing-frog (*Lophius piscatorius*). This remarkable creature has a most enormous mouth, and comparatively small body. On the top of its head are some curious bones, set just like a ring and staple, so as to move freely in every direction. A figure of this piece of mechanism will be given in a future page. At the end of these bones are little fleshy appendages, which must be very tempting to most fish, which are always looking out for something to eat. As they are being waved about, they look as if they were alive. The fish darts at the supposed morsel, and is at once engulfed in the huge jaws of the Angler-fish, which, but for this remarkable apparatus, would be scarcely able to support existence, as it is but a sluggish swimmer, and yet needs a large supply of food. The illustration, representing on the right hand a fish attracted to a bait, and on the left, the Angler-fish, with its bait-like appendage to the head, speaks for itself.



Passing to the art of Angling with a rod and line, we now arrive at another development.

Supposing a fish to have taken the bait, and to have been firmly hooked, how is it to be landed? The simplest plan is, of course, to have a very thick and strong line which will not break with the weight of any ordinary fish.

This is very well in sea-fishing, where a line made of whip-cord will answer the purpose in most cases. But, in river fishing, we have the fact that the fish are so shy that a linen thread would scare them, and so strong and active, that even whip-cord would not prevent them from breaking the line, or tearing the hook out of their mouths. So the modern angler sets himself to the task of combating both these conditions. In the first place, he makes the last yard or two of his line of "silkworm-gut"—a curious substance made from the silk-vessels of silkworms, and nearly invisible in the water. In the next place, he has a very elastic rod; and, in the third, he has forty or more yards of line, though perhaps only twenty feet are in actual use until the fish is hooked. The remainder of the line is wound upon a winch fixed to the handle of the rod. Thus, when a powerful fish is hooked and tries to escape, the line is gradually let loose, so as to yield to its efforts. When it becomes tired by the gradual strain, the line is again wound in, and in this way a fish which would at the first effort smash rod and line of a novice will, in the hands of an experienced fisherman, be landed as surely as if it were no bigger than a gudgeon.

Nature has in this case also anticipated Art, and surpassed all her powers.



NEMERTES.



"PLAYING" A FISH.

There is a wonderful worm, common on our southern coasts, and bearing, as far as I know, no popular name. It is known to the scientific world as *Nemertes Borlasii*. It possesses the power of extension and contraction more than any known creature, and uses those powers for the purpose of capturing prey. The fishermen say that this worm can extend itself to a length of ninety feet, and as Mr. Davis found one to measure twenty-two feet, after being immersed in spirits of wine, it is likely that their account may be true, especially as the spirit greatly contracted the animal in point of length.

A most vivid description of this worm is given by C. Kingsley, in his "Glaucus," and was written before he knew its name.

"Whether we were intruding or not, in turning this stone, we must pay a fine for having done so; for there lies an animal as foul and monstrous to the eye as 'hydra, gorgon, or chimæra dire,' and yet so wondrously fitted to its work that we must needs endure for our own instruction to handle and to look at it. Its name I know not (though it lurks here under every stone), and should be glad to know. It seems some very 'low' Ascarid or Planarian worm.

"You see it? That black, shiny, knotted lump among the gravel, small enough to be taken up in a dessert spoon. Look now, as it is raised and its coils drawn out. Three feet, six, nine at least; with a capability of seemingly endless expansion; a slimy tape of living caoutchouc, some eighth of an inch in diameter, a dark chocolate black, with paler longitudinal lines.

"Is it alive? It hangs helpless and motionless, a mere velvet string, across the hand. Ask the neighbouring Annelids and the fry of the rock-fishes, or put it into a vase at home, and see. It lies motionless, trailing itself among the gravel; you cannot tell where it begins or ends; it may be a dead strip of seaweed, *Himanthalia lorea*, perhaps, or *Chorda filum*, or even a tarred string.

"So thinks the little fish who plays over and over it, till he touches at last what is too surely a head. In an instant a bell-shaped sucker mouth has fastened to his side. In another instant, from one lip, a concave double proboscis, just like a tapir's (another instance of the repetition of forms), has clasped him like a finger; and now begins the struggle: but in vain. He is being 'played' with such a fishing-line as the skill of a Wilson or a Stoddart never could invent; a living line, with elasticity beyond that of the most delicate fly-rod, which follows every lunge, shortening and lengthening,

slipping and twining round every piece of gravel and stem of seaweed, with a tiring drag such as no Highland wrist or step could ever bring to bear on salmon or on trout.

“The victim is tired now; and slowly, and yet dexterously, his blind assailant is feeling and shifting along his side, till he reaches one end of him; and then the black lips expand, and slowly and surely the curved finger begins packing him end foremost down into the gullet, where he sinks, inch by inch, till the swelling which marks his place is lost among the coils, and he is probably macerated to a pulp long before he has reached the opposite extremity of his cave of doom.

“Once safe down, the black murderer slowly contracts again into a knotted heap, and lies, like a boa with a stag inside him, motionless and blest.”

The accuracy as well as the pictorial effect of this description cannot be surpassed. The “velvety” feel of the creature is most wonderful, as it slips and slides over and among the fingers, and makes the task of gathering it together appear quite hopeless.

This astonishing worm is drawn on the left hand of the illustration on page 93, so as to show the way in which the body is contracted or relaxed at will. On the other side of the illustration is an angler, armed with all the paraphernalia of his craft, and doing imperfectly that which the Nemertes does with absolute perfection.

A similar property belongs to the long, trailing tentacles of the Cydippe, which is described and figured on page 16. When they come in contact with suitable prey, all struggle is useless, the tentacles contracting or elongating to suit the circumstances, and at last lodging the prey within the body of the Cydippe.

The Spring-trap

We are all familiar with the common Spring-trap, or Gin, as it is sometimes called.

It varies much in form and size, sometimes being square and sometimes round; sometimes small enough to be used as a rat-trap, and sometimes large enough to catch and hold human beings, in which case it was known by the name of man-trap. This latter form is now as illegal as the spring-gun, and though the advertisement “Man-traps and Spring-guns are set in these grounds” is still to be seen, neither one nor the other can be there.

They are all constructed on the same principle, namely, a couple of toothed jaws which are driven together by a spring, when the spring is not controlled by a catch. They are evidently borrowed from actual jaws, the same words being used to signify the movable portions and notches of the trap as are employed to designate the corresponding parts in the real jaw.

In both figures of the accompanying illustration we shall see how exact is the parallel. On the right hand is a common rat-trap, or gin, such as is sold for eightpence, with the jaws wide open, so as to show the teeth. On the left is a sketch of the upper and lower jaws of the Dolphin, in which an exactly analogous structure is to be seen.



JAWS OF DOLPHIN (OPEN).

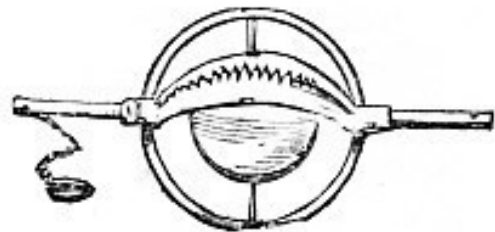


RAT-TRAP (OPEN).

The figure on the right hand of the lower illustration shows a man-trap as it appears when closed, the teeth interlocking so as exactly to fit between each other. The same principle is exhibited in the jaws of the Porpoise, which are seen on the left of the illustration. The jaws of an Alligator or Crocodile would have answered the purpose quite as well, inasmuch as their teeth interlock in a similar fashion, but I thought that it would be better to give as examples the jaws of allied animals. The reason for this interlocking is evident. All these creatures feed principally on fish, and this mode of constructing the jaws enables them to secure their prey when once seized.

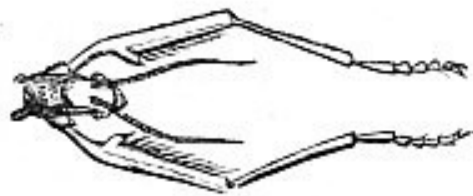


JAWS OF PORPOISE (CLOSED).

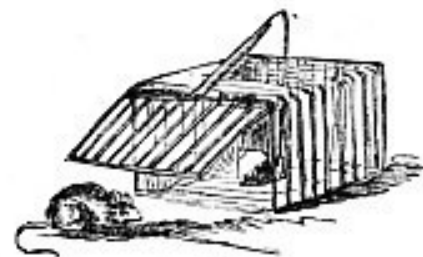


MAN-TRAP (CLOSED).

Another example of such teeth is to be found in the fore-legs of various species of Phasma and Mantis, as may be seen by reference to the illustration. The latter insects are wonderfully fierce and pugnacious, fighting with each other on the least provocation, and feeding mostly on other insects, which they secure in their deeply-toothed fore-legs. They use these legs with wonderful force and rapidity, and it is said that a pair of these insects fighting remind the observer of a duel with sabres.



FORE-LEGS OF PHASMA.



MOUSE-TRAP.

The Baited Trap

Our space being valuable, we are not able to give many examples of Baited Traps, whether in Art or Nature.

The most familiar example of this trap is the common Mouse-trap, the most ordinary form of which is shown at the right hand of the illustration on page 96. In all the varieties of these traps, whether for mice or rats, the prey is induced to enter by means of some tempting food, and then is secured or killed by the action of the trap. Sometimes these traps are made of considerable size for catching large game, and in Africa are employed in the capture of the leopard, in India for taking both tigers and leopards, and in North America for killing bears.

We have already noticed one instance of a bait in the Angler-fish, described in page 92, but in this case the bait serves only for attraction, and the trap, or mouth, is not acted upon by the prey.

There are, however, many examples in the botanical world, where the plant is directly acted upon by the creature which is to be entrapped, such being known by the now familiar term "Carnivorous Plants." Of these there is a great variety, but under this head I only figure two of them.



CEPHALOTUS.



DIONEA.

The plant on the right hand is the Venus Fly-trap (*Dionea muscipula*), which is common in the Carolinas. The leaves of this plant are singularly irritable, and when a fly or other insect alights on the open leaf, it seems to touch a sort of spring, and the two sides of the leaf suddenly collapse and hold the insect in their grasp. The strange point about it is, that not only is the insect caught, but is held until it is quite digested, the process being almost exactly the same as if it had been placed in the stomach of some insect-eating animal.

So carnivorous, indeed, is the Dionea, that plants have been fed with chopped meat laid on the leaves, and have thriven wonderfully. Experiments have been tried with other substances, but the Dionea would have nothing to do with them. The natural irritability of the leaves caused them to contract, but they soon opened and rejected the spurious food.

On the left is the Cephalotus. This plant, instead of catching the insect by the folding of the leaf, secures it by means of a sort of trap-door at the upper end. The insect is attracted by the moisture in the cup, and, as soon as it enters, the trap-door shuts upon it, and confines it until it is digested, when the door opens in readiness to admit more prey.

Birdlime

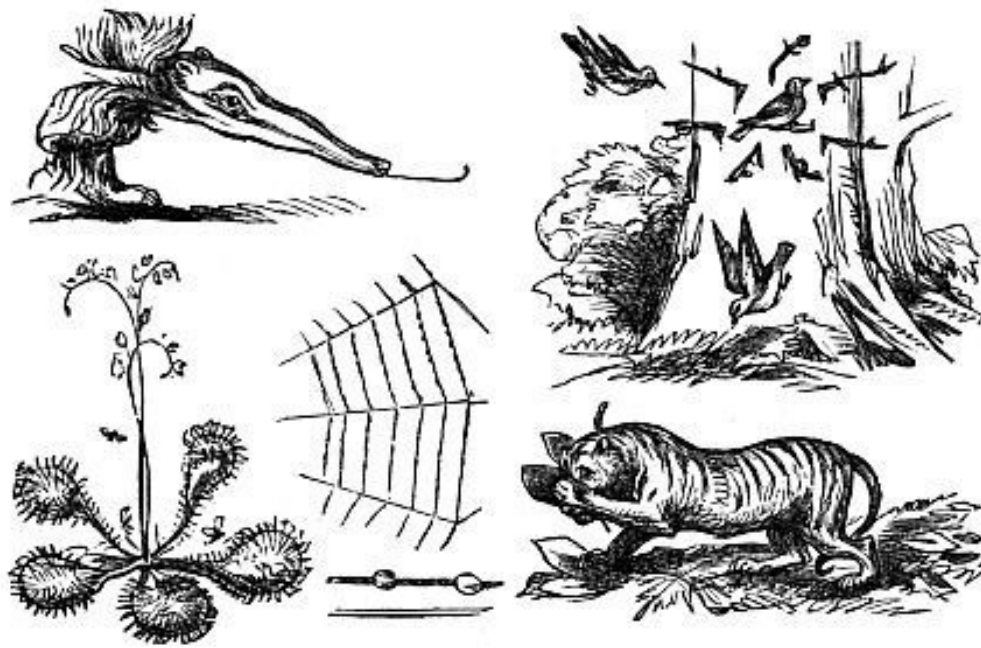
By a natural transition we pass to those traps which secure their prey by means of adhesive substances.

With us, the material called “birdlime” is usually employed. This is obtained from the bark of the holly, and is of the most singular tenacity. An inexperienced person who touches birdlime is sure to repent it. The horrid stuff clings to the fingers, and the more attempts are made to clear them, the more points of attachment are formed. The novice ought to have dipped his hands in water before he touched the birdlime, and then he might have manipulated it with impunity.

The most familiar mode of using the birdlime is by “pegging” for chaffinches.

In the spring, when the male birds are all in anxious rivalry to find mates, or, having found them, to defend them, the “peggers” go into the fields armed with a pot of birdlime and a stuffed chaffinch set on a peg of wood. At one end of this peg is a sharp iron spike. They also have a “call-bird,” *i.e.* a chaffinch which has been trained to sing at a given signal.

When the “peggers” hear a chaffinch which is worth taking, they feel as sure of him as if he were in their cage. They take the peg, and stick it into the nearest tree-trunk. Round the decoy they place half-a-dozen twigs which have been smeared with birdlime, and arrange them so that no bird flying at the decoy can avoid touching one of them.



ANT-BEAR. DROSERA. SPIDER'S WEB. PEGGING CHAFFINCHES. TIGER AND LINED LEAVES.

The next point is, to order the call-bird to sing. His song is taken as a personal insult by the chaffinch, which is always madly jealous at this time of year. Seeing the stuffed bird, he takes it for a rival, dashes at it, and touches one of the twigs. It is all over with him, for the more he struggles and flutters, the tighter is he bound by the tenacious cords of the birdlime, and is easily picked up by the "pegger."

Even the fierce and powerful tiger is taken with this simple, but terrible means of destruction. It is always known by what path a tiger will pass, and upon this path the native hunter lays a number of leaves smeared with birdlime. The tiger treads on one of them, and, cat-like, shakes his paw to rid himself of it. Finding that it will not come off, he rubs his paw on his head, transferring the leaf and lime to his face.

By this time he is in the middle of the leaves, and works himself into a paroxysm of rage and terror, finishing by blinding himself with the leaves that he has rubbed upon his head. The hunters allow him to exhaust his strength by his struggles, and then kill him, or, if possible, capture him alive.

Both these scenes are represented on the right hand of the illustration.

On the left hand are several examples of natural birdlime, if we may use the term. The upper represents the Ant-bear, or Great Ant-eater. This animal feeds in a very curious manner. It goes to an ant-hill, and tears it open with its powerful claws. The ants, of course, rush about in wild confusion. Now, the Ant-eater is provided with a long, cylindrical tongue, which looks very like a huge earth-worm, and which is covered with a tenacious slimy secretion. As the ants run to and fro, they adhere to the tongue, and are swept into the mouth of their destroyer.

Below the Ant-eater is the common Drosera, or Sundew, one of our British carnivorous plants. It captures insects, just as has been narrated of the Dionea. But, instead of the leaf closing upon the insect, it arrests its prey by means of little globules of viscous fluid, which exude from the tips of the hairs with which the surface of the leaf is covered. As soon as the insect touches the hairs, they close over it, bind it down, and keep it there until it is digested. Several species of Drosera are known in England, and are found in wet and marshy places.

Another plant, the Green-winged Meadow Orchis (*Orchis morio*), has been known to act the part of the Drosera. A fly had contrived to push its head against the viscous fluid of the stigmatic surface, and, not being able to extricate itself, was found sticking there.

Next comes a portion of the web of the common Garden Spider (*Epeira diadema*). We have already treated of this web as a net, and we will now see how it comes within the present category.

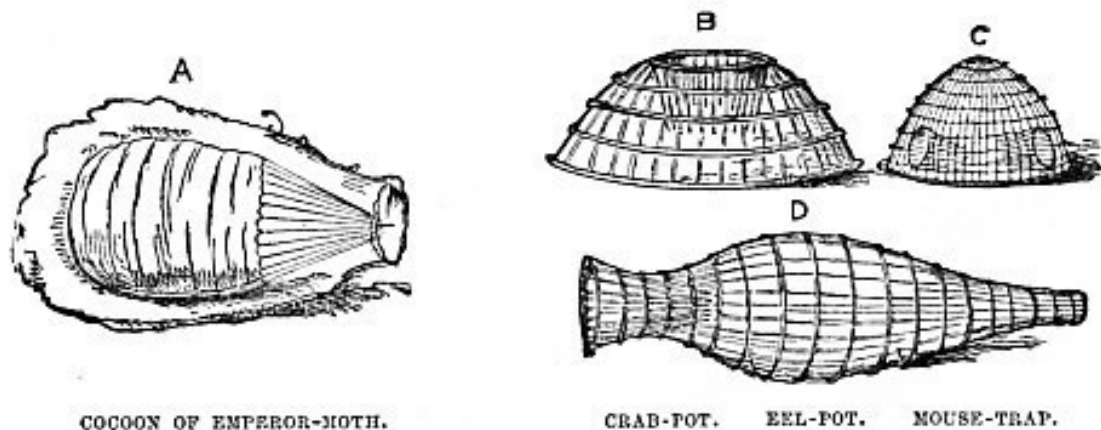
In the web of the spider there are at least two distinct kinds of threads. Those which radiate from the centre to the circumference are strong and smooth, while those which unite them are much slighter, and are covered with tiny globules set at regular intervals. When the web is newly spun, these globules are found to be nearly as tenacious as birdlime, and it is by these means that an insect which falls into the web is arrested, and cannot extricate itself until the spider can seize it. After awhile the globules become dry, refuse to perform their office, and then the spider has to construct another web. So numerous are these globules that, according to Mr. Blackwall's calculations, an ordinary net contains between eighty and ninety thousand. Below the figure of the web itself are shown the two kinds of thread, the upper bearing the globules, and the lower representing one of the plain radiating threads.

CHAPTER V

Reverted Spikes and their Modifications.—The Wire Mouse-trap.—George III. and the Trap.—Fate of a Royal Finger.—The Crab and Lobster Pot.—The Eel-pot.—Cocoon of the Emperor-moth and its Structure.—“Catchpoll” of the Middle Ages.—Deer-trap of India.—Jaws of Pike and Serpent.—The Grass-snake.—Jaws of Shark and their Power.—Spiked Defences.—The Park Fence, the Garden Wall, and the Chevaux-de-frise.—The “Square” of Infantry Manœuvres.—The Abattis, and its Structure and Power.—Ranjows and Caltrops.—Ancient Ranjows in Ireland.—Hedgehog.—Porcupine Echidna.—House-builder Caterpillar and its Home.—Repagula of Ascalaphus.—Tearing Weapons.—The “Wag-nuk” of India.—Armed Gauntlet of the Middle Ages.—Shark-tooth Gauntlet of Samoa, and the Uses to which it was put.—A terrible Warrior.—The Tiger’s Claw.—Sport and Earnest.

Reverted Spikes

I am not quite satisfied with this title, but it is the best that I can find. By it I mean that mode of mechanism which, by means of an array of sharp spikes, permits an animal to enter a passage easily, and yet prevents it from emerging.



COCOON OF EMPEROR-MOTH.

CRAB-POT.

EEL-POT.

MOUSE-TRAP.

Whether or not this principle be now employed in warfare I cannot say, but it is at all events used extensively in a small way of hunting, the best known of which is the wire Mouse-trap, one of which is shown at Fig. C on the illustration. A glance at the figure will explain the trap, even to those who have never seen it. It is composed entirely of wire, and has several round holes just above its lower edge. Each of these holes is the entrance to a conical tunnel made of wires with sharpened ends.

The mouse, being attracted by a bait placed within the trap, tries to get at it. The doomed animal soon finds its way to one of the entrances, and with little difficulty pushes itself through the tunnel. Entering, however, is one thing, and returning is another. The wire yielded easily enough in one direction, but for the mouse to force itself against the converging points is an impossible task.

Readers of the last century literature may perhaps remember, in the pages of “Peter Pindar,” a very clever and sarcastic account of the astonishment created in the mind of George III. by a mouse-trap seen accidentally in the house of a widow living at Salt Hill.

“Eager did Solomon, so curious, clap

His rare round optics on the widow's trap,
That did the duty of a cat.
And, always fond of useful information,
Thus wisely spoke he with vociferation,—
'What's that? what? what? Hæ, hæ? what's that?'

To whom replied the mistress of the house,
'A trap, an't please you, sir, to catch a mouse.'

'Mouse—catch a mouse!' said Solomon with glee;
'Let's see, let's see—'tis comical—let's see—
Mouse! mouse!'—then pleased his eyes began to roll—
'Where, where doth he go in?' he marvelling cried.
'There,' pointing to the hole, the dame replied.
'What! here?' cried Solomon, 'this hole? this hole?'
Then in he pushed his finger 'midst the wire,
That with such pains that finger did inspire,
He wished it out again with all his soul."

For my part I think that the King was quite right. If he did not know the philosophy of a mouse-trap he ought to have asked, and to have been rewarded, as in that case, by catching with a trap of his own baiting, six mice on six successive days.

At Fig. B on the same illustration is shown the simple apparatus by which crabs and lobsters are caught. The reader will see that the principle is exactly the same in both cases, the only difference being in material, the mouse-trap being made of wire, and the crab-pot of wicker.

At Fig. D is shown the common Eel-pot, or Eel-basket. In order to suit the peculiar shape of an eel, this basket is much longer in proportion to its diameter than either of the preceding traps, but it is formed on the same plan. An eel can easily pass into the basket through the conical tunnel, but it is next to impossible that it should find its way out again.

So much for Art, and now for Nature.

On the left hand of the illustration, at Fig. A, is the cocoon of the common Emperor-moth (*Saturnia pavonia minor*), the cocoon having been stripped of its outer envelope, so as to allow its structure to be better seen.

The reader will at once perceive that the entrance of the cocoon is guarded by an arrangement exactly like that of the above-mentioned traps, except that the cone is reversed, so as to allow of exit and to debar entrance. Guarded by this conical arrangement of stout bristly appendages, the pupa can remain in quiet during the time of its transformation, for nothing can force its way through such a defence, and yet the moth, when fully developed, can push its way out with perfect ease.

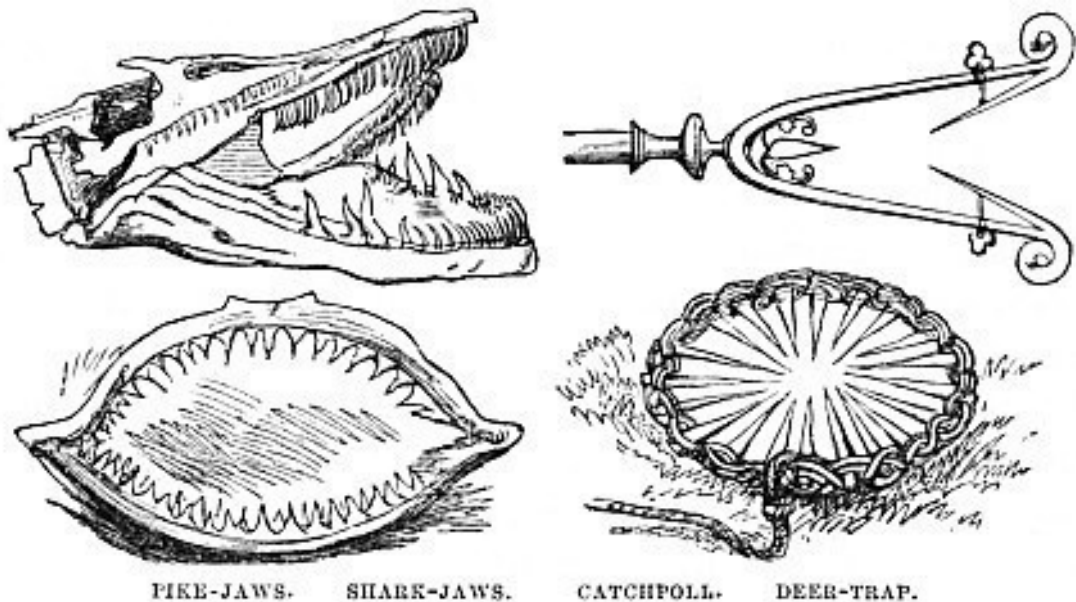
So admirably is this cocoon formed, that even after the moth has escaped, it is impossible to tell by mere sight whether or not it is within, the elastic wires closing on it after its passage.

Another modification of the same principle now comes before us. In the above-mentioned examples the arrangement of the reverted spikes is more or less conical, and they lead into a chamber. In the present instances, however, the mere reversion of the points is all that is needed.

The upper figure on the right hand represents the "Catchpoll" of the Middle Ages, an allusion to which has already been made. The reverted spikes turn on hinges, and are kept apart by springs. This beautifully formed head was attached to a long shaft, and was used for the purpose of dragging horsemen from the saddle. It was thrust at the neck of the rider, generally from behind. If a successful thrust were made, the spring-points gave way, sprang back again, and thus clasped the neck with a hold that was fatal to the rider.

Below it is the Deer-trap which is used in many parts of India, and to which allusion has already been made. The reader will see at once that if a deer should get its foot through the converging spikes, its doom is sealed, especially as there is a heavy log of wood attached to the trap by a rope.

On the left hand of the illustration are two examples of the same principle taken from Nature, one belonging to fresh and the other to salt water.



The upper figure represents the jaws of a Pike, with their terrible array of reverted teeth. The Pike, as every one knows, feeds upon other fish, and eats them in a curious manner. It darts at them furiously, and generally catches them in the middle of the body. After holding them for a time, for the purpose, as I imagine, of disabling them, it loosens its hold, makes another snap, seizes the fish by the head, and swallows it.

The Pike is so voracious that it will attack and eat fish not very much smaller than itself, for its digestion is so rapid that the head and shoulders of a swallowed fish have been found to be half digested, while the tail was sticking out of the Pike's mouth. Unless, therefore, the teeth of the Pike were so formed as to resist any retrograde movement on the part of the prey, the fish would starve; for, lank and lean as it is, the Pike is one of the most voracious creatures in existence, never seeming able to get enough to eat, and yet, as is often found in such cases, capable of sustaining a lengthened fast.

How well adapted is this arrangement of teeth for preventing the escape of prey, any one can tell who, in his early days of angling, caught a Pike, and, after killing it, tried to extract the hook without previously propping the jaws open. If once the hand be inserted between the jaws, to get it out again is almost impossible without assistance, and often has the spectacle been exhibited of a youthful angler returning disconsolately home, with his right hand in the mouth of a Pike, and supporting the weight of the fish with his left.

The teeth of a serpent are set in a similar manner, as can be seen by reference to the illustration on page 80. An admirable example of the power of this arrangement may be seen in the jaws of our common Grass or Ringed Snake (*Coluber natrix*). The teeth are quite small, very short, and not thicker than fine needle-points. Yet, when once the snake has seized one of the hind-feet of a frog, all efforts to escape on the part of the latter are useless. The lower jaw is pushed forward, and then retracted, and at each movement the leg is drawn further into the snake's mouth, until it reaches the junction.

The snake then waits quietly until the frog tries to free itself by pushing with its other foot against the snake's mouth. That foot is then seized, the leg gradually following its companion, and in this way the whole frog is drawn into the interior of the snake. I have seen many frogs thus eaten, but

never knew one to escape after it had been once seized by the snake. As these reptiles are perfectly harmless, it is easy to try the experiment by putting the finger into a snake's mouth, when it will be found that the assistance of the other hand will be needful in order to extricate it.

Below the head of the pike is a view of a Shark's jaws, as seen from the front.

Here, again, we have a similar arrangement of teeth, row after row of which lie with their points directed towards the throat of the fish. As, however, the pike and the snake swallow their prey whole, their teeth need be nothing but points. But, as the Shark is obliged to mangle its prey, and seldom swallows it whole, its teeth are formed on a different principle, each tooth being flat, wide, sharply pointed, and having a double edge, each of which cuts like a razor. So knife-like are they, indeed, that when a whale is killed, the sharks which surround it bite off huge mouthfuls of blubber, and, as they swarm by hundreds, cause no small loss to the whalers.

Many a man has lost a leg by a shark, the fish having bitten it completely through, bone and all, and there have been cases where a shark has actually severed a man's body, going off with one half, and leaving the other clinging to the rope by which he was trying to haul himself on board.

Spiked Defences

This mode of defence is, perhaps, one of the most primitive in existence, and takes a wonderful variety of forms. The spiked railings of our parks and gardens, the broken glass on walls, and even the spiked collars for dogs, are all modifications of this principle.

On the illustrations are several examples of spikes used for military purposes. The first is known by the name of "Chevaux-de-frise," and is extensively used in forming an extemporised fence where no great strength is needed. The structure is perfectly simple, consisting of a number of iron bars with sharpened ends, and an iron tube some inches in diameter, which is pierced with a double set of holes. When not in use, the bars and tube can be packed in a small compass, but when they are wanted, the bars are thrust through the holes as shown in the illustration, and the fence is completed in a few minutes. The horizontal bars are linked together by chains, so as to prevent them from being shifted, and a defence such as this is generally used for surrounding parks of artillery and the like.

All who have the least acquaintance with military matters must be familiar with the "Square," and its uses in the days of old. I say in the days of old, because in the present day the rapid development of guns and rifles has entirely destroyed the old arrangement. So lately, for example, as the day of Waterloo, troops might manœuvre in safety when they were more than two hundred yards from the enemy. Now, a regiment that attempted to manœuvre in open ground would be cut to pieces by the rifles of the enemy at a thousand yards' distance.

In those days, however, the square was a tower of safety when rightly formed. It was formed in several rows. The outer line knelt, with the butts of their muskets on the ground, and the bayonet pointing upwards at an angle of forty-five. The others directed their muskets towards the enemy in such a manner that nothing was presented to him but the points of bayonets and the muzzles of loaded muskets. In all probability the battle of Waterloo would have been lost but for the use of the "square," against which the French cuirassiers dashed themselves repeatedly, but in vain.

However admirable may be the organization of the square, whether it be hollow, or whether it be solid, like the "rallying square," the principle is the same as that of the chevaux-de-frise.

In the next illustration is shown the "Abattis," one of the most important elements of extemporised fortifications, and as simple as it is important.



TREE-CADDIS.



CHEVAUX-DE-FRISE.

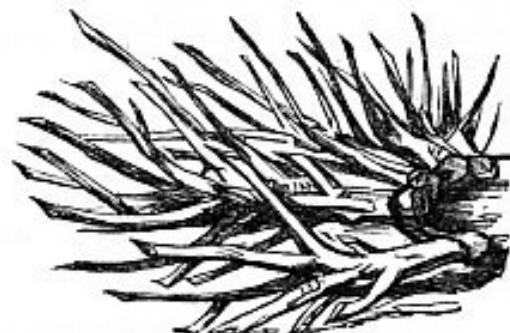
In any wooded country an abattis can be made in a very short time by practised hands. All that is required is to cut down the requisite number of trees, strip off the leaves and twigs, and then cut off the smaller branches with sloping blows of the axe, so as to leave a tolerably sharp point on each. The trees are then laid side by side, with the ends of the branches towards the enemy, and, the trunks being chained together, a wonderfully effective defence is constructed.

Not only is it almost impossible for the bravest and strongest man to force his way through the branches, even if the abattis were undefended, but the tree-trunks afford shelter for swarms of riflemen, who can pick off their assailants by aiming between the branches, themselves being almost unseen, and entirely covered.



CALTROPS.

RANJOWS.



ABATTIS.

In Southern Africa, during the late wars, the abattis was found to afford the best defence against the Kafirs, and that when the waggons and abattis were united so as to form a fortress, not even the naked Kafir, with all his daring courage, could force his way through them. Even artillery has but little power against the abattis, which allows the shot to pass between the branches, and is very little the worse for it. Accordingly, it is in great use for defending roads, especially those which are bounded by high banks, and makes a formidable obstacle in front of gates.

The two figures on the left of the same illustration represent two modes of carrying out the same principle, the one showing it as used in European warfare, and the other as a weapon of defence which has been employed from time immemorial, and is now in full use in many parts of the world.

Both these weapons are intended either to obstruct the approach of an enemy, or to cover the flight of a retreating force. The most simple and most ancient is the Ranjow, which is shown on the right hand of the illustration. The ranjow is nothing but a wooden stick varying in length from eighteen inches to nearly three feet, and sharply pointed at each end. In Borneo, China, &c., the ranjows are almost invariably made of bamboo, as that plant can be cut to a sharp point by a single stroke of a knife. (See page 59.)

When they are to be used, each soldier carries about a dozen or so of them, and sticks one end of them into the ground, taking care to make the upper end lean towards the enemy. Simple as are these weapons, they are extremely formidable, for it is necessary to pull up every ranjow before the troops can advance. Sometimes it has happened that a body of soldiers are driven over their own ranjows, and then the slaughter is terrible.

Some years ago a number of sketches were taken on the spot from scenes in the Chinese war. Among them was one that was absolutely terrible in its grotesqueness. It represented a piece of ground thickly planted with ranjows, over which the Chinese who had fixed them had been driven. They were simply hung with human bodies in all imaginable and unimaginable attitudes, some transfixed on a single ranjow, and others hanging on three or four, the body and limbs being alike pierced by them.

That ranjows were once used in Great Britain is evident from a discovery made by Col. Lane Fox. He had been excavating the soil around an old Irish fort, and deep beneath the bog he found a vast quantity of ranjows still set as the ancient warriors had left them. They were evidently used to defend a passage leading to the fort, and all of them were carefully set with their points outwards. Col. L. Fox was good enough to present me with several of these ancient weapons, which are now in my collection.

On the left is seen a piece of ground strewed with Caltrops, or Crow's-feet, as they are sometimes called. These very unpleasant implements are made of iron, and have four sharp points, all radiating from one centre, so that no matter how they may be thrown, one point must be uppermost. They are used chiefly for the purpose of impeding cavalry, but I should think, judging from the specimens which I have seen, that infantry would find them very awkward impediments.

As for natural ranjows, they are so numerous that only a very few examples can be given.

The most perfect and most familiar example is, perhaps, the common Hedgehog, which, when rolled up, displays an array of sharp points so judiciously disposed, that it fears but very few foes. The same may be said of the Australian Echidna, or Porcupine Ant-eater, and the Porcupine itself. Whether the radiating bristles of the larva of the Tiger-moth, commonly called the Woolly Bear, come under the same category, I cannot say, but think it very likely.

Among vegetables the analogues are multitudinous. See, for example, the spikes of the Spanish and Horse Chestnuts, and especially the hair-like but formidable bristles which defend the common Prickly Pear. Indeed, all that tribe of plants is furnished so abundantly with natural ranjows, that a hedge of prickly pear forms the best defence which a house and garden can have.

Another example of natural ranjows is seen in the Tree-caddis, one of which is shown in the illustration on page [108](#), as it appears when suspended from a twig. It is the work of one of the House-builder Moths of the West Indies, and forms a sort of house in which the caterpillar can rest securely. It is built of bits of twigs and thorns, the latter being disposed so that their points are outwards, much after the fashion of a hedgehog's spines.

I possess many specimens of Tree-caddis, evidently belonging to several species, and in all of them the principle is the same, *i.e.* a number of spikes set with their ends outwards in order to defend a central position.

Sometimes these spikes are left exposed, as shown in the illustration, and sometimes they are covered with a slight but strong web. The principle, however, is the same in all.

Now I shall have to use two very long words, and much against my will. I very much fear that, if most of my readers were to hear any one speak of the “repagula of Ascalaphus,” they would not be much the wiser. And yet there are no other words that can be used.

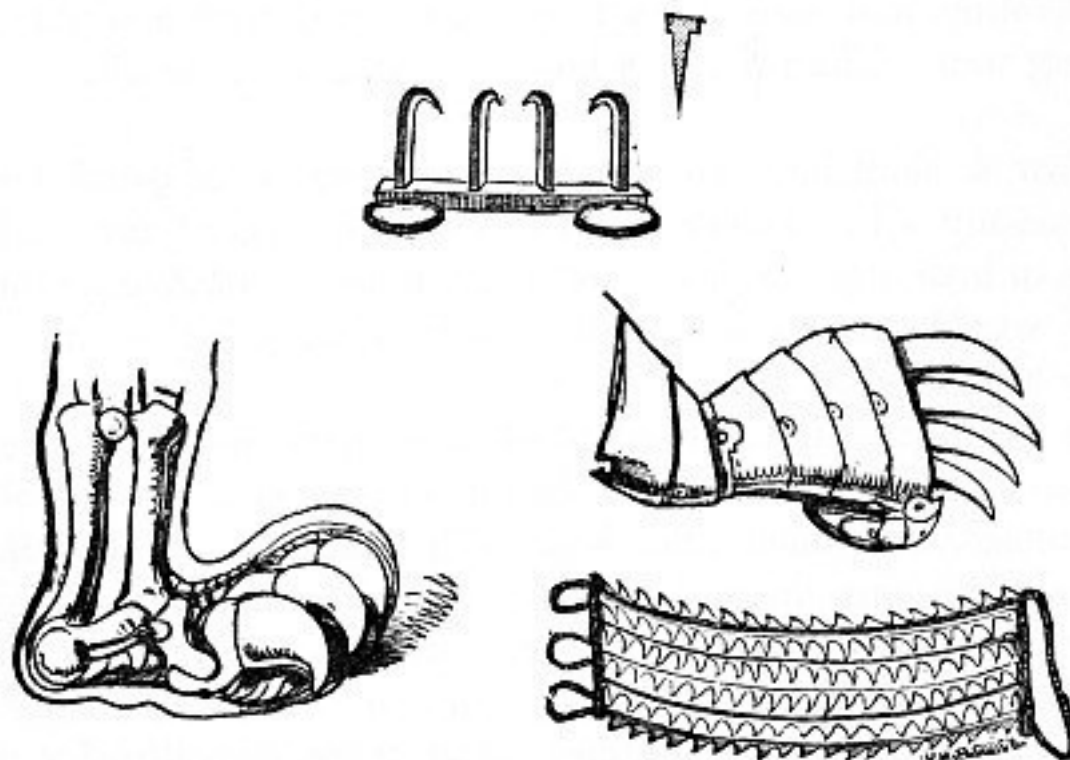
In the first place, Ascalaphus is a name belonging to a genus of Ant-lions, remarkable for having straight, knobbed antennæ, very much like those of a butterfly. This insect deposits its eggs in a double row on twigs, and then defends them with a series of natural ranjows, set in circular rows, and supposed to be without analogies in the animal creation. They are transparent, reddish, and “are expelled by the female with as much care as though they were real eggs, and are so placed that nothing can approach the brood; nor can the young ramble abroad until they have acquired strength to resist the ants and other insect enemies.”

The word “repagulum,” by the way, signifies a bar or barrier. A turnpike gate when closed would be a repagulum, and so would a chevaux-de-frise.

Tearing Weapons

We have already had examples of weapons, like the Club, which bruise; of weapons, like the Spear and Dagger, which pierce; and of weapons, like the Sword, which cut. We now come to a totally distinct set of weapons, those which wound by tearing, and not by any of the preceding modes.

In civilised warfare we have long abandoned such weapons, as belonging to a barbarous age, but they are even yet employed in some parts of the world.



WAG-NUK OF INDIA.

HIND-CLAWS OF TIGER.

CLAWED GAUNTLET.
SHARK-TOOTH GAUNTLET.

The accompanying illustration shows three examples of such weapons. One is the celebrated Tiger-claw of India, known by the native name of Wag-nuk. It is about two inches and a half in length, and is made to fit on the hand. The first and fourth fingers are passed through the rings, and

the curved claws are then within the hand, and hidden by the fingers. The mode of employing this treacherous weapon was by engaging a foe in conversation, pretending to be very friendly, and then ripping up his stomach with an upward blow of the right hand.

It is comparatively a modern weapon, having been invented about two hundred years ago. A Hindoo, named Sewaja, was the inventor, and by means of the Wag-nuk he committed many murders unsuspected, the wounds being exactly like those which are made by the claw of the tiger. Sometimes there were four claws instead of three, as is the case with a specimen one in the Meyrick collection.

Perhaps the reader may be aware that the Transatlantic “knuckle-duster” is fitted on the hand in the same manner, only its object is to strike a heavy blow, and not to tear. History repeats itself, and the large and clumsy “cestus” of the ancient athlete is reproduced in the small but scarcely less formidable “knuckle-duster” of the modern rowdy.

The figures are remarkable, one representing the remaining epoch of chivalry, and the other that of barbarism. The upper figure shows a curious Gauntlet of the Middle Ages, in which the hand is not only defended by steel plates, but is also rendered an offensive weapon by the addition of four sharp spikes set just at the junction of the fingers with the hand. As long as the fingers are extended the spikes lie parallel with them, and are as harmless as a cat's claws in their sheaths. But when the fingers are closed, as shown in the illustration, the spikes come into use, and can be made into a formidable weapon of offence, just as are the cat's claws when protruded.

Below the gauntlet of civilised warfare is one of savage war, which has for many years been discontinued, partly on account of the introduction of firearms, and partly owing to the superficial coating of civilisation which is so easily adopted by the singular varieties of the human race which populate the isles where this remarkable weapon was once worn. The figure is taken from a specimen in the United Service Museum.

It is a Gauntlet, having at one end a band through which the whole hand is passed, and at the other three loops for the fingers, just like those of the Wag-nuk, which has already been described. The body of the weapon is made of cocoa-nut fibre, and upon it are strung six rows of sharks' teeth, the tips all pointing backwards. It is a Samoan weapon, some of the most renowned warriors never using club nor spear, but trusting entirely to their terrible gauntlets. With these they struck right and left, dashing beneath the clubs and spears of their enemies, and always trying to rip up their stomachs, just as is done with the Wag-nuk. In order to guard against this weapon, the Samoan warrior wears a belt of cocoa-nut fibre some eight inches wide, and thick enough to defy the best gauntlet that could be made.

One celebrated Samoan warrior, a man of gigantic stature and strength, was addicted to the amusement of seizing his enemies with the shark-tooth gauntlets, breaking their backs across his knee, throwing them down, and going off after another victim.

On the left hand of the illustration is seen the hind-foot of the Tiger. I have chosen the hind-foot for two reasons: firstly, because the fore-foot has already been figured; and secondly, because the hind-foot is used for tearing open the abdomen of the prey. Any one who has played with a kitten has noticed how the animal throws itself on its back, clasps the wrist with its fore-paws, and kicks vigorously with its hind-legs. It does not mean to hurt its playfellow, but the hand does not easily escape without sundry scratches.

Child's play though it may be in the kitten, it is no play at all with the tiger, or even the leopard, for either of these animals, when hard pressed, will throw itself on its back, clasp the foe in its fore-paws, and with the talons of the hind-feet tear him to pieces.

CHAPTER VI. THE HOOK.—DEFENSIVE ARMOUR.—THE FORT

Anglers and their Hooks.—Single and double Hooks.—Hook of British Columbia.—Seed of Galium, or Goose-grass, and its Armature of Hooks.—Seed of the Burdock, and its Annoyance to Sheep.—Hooked Sponge-spicules.—“Snatching” Fish.—The Fish-rake of British Columbia.—The “Gaff” and its Uses.—The Jaguar as a Fisher—Defensive Armour and its Varieties.—Plate and Chain Mail.—The Shield.—Australian and West African Shields.—Fibre Armour.—Seal’s-tooth Cuirass.—Joints of Armour.—“Tassets.”—Scale Armour in Art and Nature.—The Manis and the Fish.—Feather Armour.—“Madoc in Aztlan.”—Quilted Armour of Silk or Cotton.—Terrible Results from the latter.—Mr. Justice Maulstatute.—Natural Quilt Armour.—The Rhinoceros and the Whale.—The Testudo of the ancient Romans, and its Uses.—The common Tortoise.—The Fort.—Curious Transitions in Fort building; first Earth, then Stone, then Earth again.—Advantage of Earthen Mounds.—Natural Snow-fort made by the Elk, and its Defensive Powers against the Wolf.

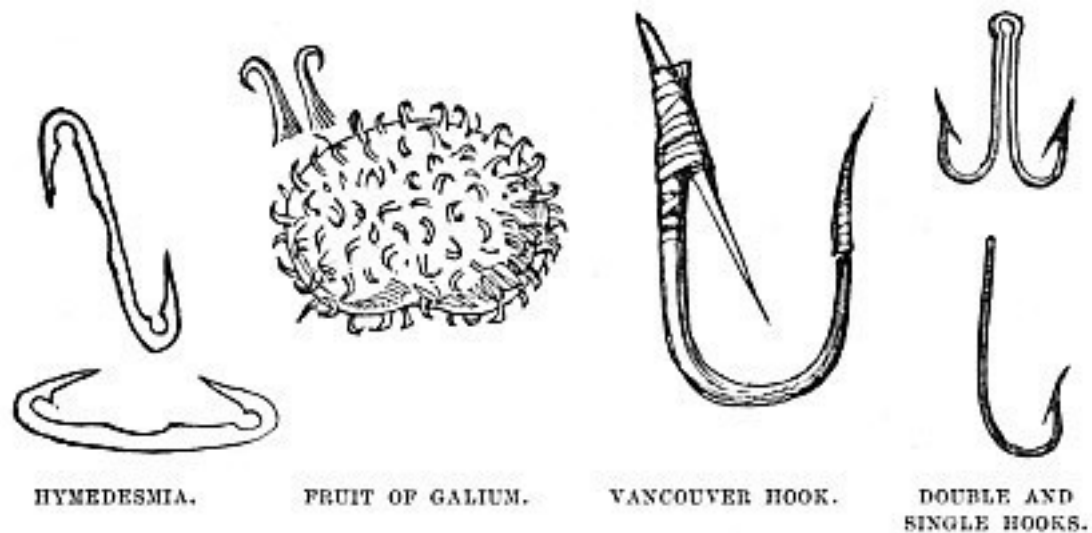
The Hook

HAVING now seen that the rod and line of anglers have their prototypes in Nature, we will proceed to the hook, by which the fish are secured.

The two figures on the right hand of the accompanying illustration represent hooks which are familiar to every angler. The lower is the ordinary fish-hook, which can be used in so many ways. Generally it is employed singly, being fastened to the end of a line, and armed with a bait, either real or artificial. Sometimes, however, these hooks are whipped together, back to back, three or even four being so employed, and thus forming a combination of the hook and grapnel, and rendering the escape of a fish almost impossible.

Above it is a double hook, such as is used in “trolling” for pike, and with the use of which many of my readers are probably acquainted.

The third is a singularly ingenious hook made by the natives of British Columbia. It is almost entirely made of wood, with the exception of the barb, which is of bone. This, as the reader will see, is fixed, not to the point of the hook, as with us, but to its base, the point being directed towards the central portion of the curve.



At first sight this seems to be a singular arrangement, but it is a very effective one, as any one may see by placing the point between the fingers and pushing it through them. It will be found impossible to force it back again, the sharp point of the bone-barb coming against them and retaining them.

It has also another advantage. Very large fish, for which this hook is intended, are apt in their struggles to reverse the hook, and so to weaken its hold. In this hook, however, such a proceeding is impossible; for, even should the hook be reversed, it still retains its hold, the barb becoming the point, and the point keeping the lip of the fish against the tip of the barb. The figure is drawn from a specimen in my collection.

If the reader will look at the illustration, he will see a globular object covered with little hooks. This is a magnified representation of the seed-vessel of the common Goose-grass (*Galium*), which is so luxuriant in our hedges, and often intrudes itself into our gardens. Its long, trailing stems, with their tightly-clinging leaves, are familiar to all, and there are few who have not, while children, pelted each other with the little round green seed-vessels during the time that the fruit is in season. That they clung so tightly as not to be removed without difficulty, we all knew, but we did not all know the cause. The magnifying-glass, however, reveals the secret at once. The whole of the surface is covered with little sharp prickles, curved like hooks, and turned in all directions, so that, however it may be thrown, some of them are sure to catch.

So readily do these hooks hold to anything which they touch, that if a lady only sweeps her dress against a plant of Goose-grass, she is sure to carry off a considerable number of the seed-vessels, and to waste much time afterwards in picking them off.

The seed-vessel of the common Burdock, known popularly by the name of Bur, is armed in a similar manner, but, as it is much larger, it is easily avoided. Sheep suffer greatly from burs, which twist themselves among the wool so firmly that it is hardly possible to remove them without cutting away bur and wool together. As to a Skye terrier, when once he gets among burs, his life is a misery to him (I was going to say, a burden to him, but it would have looked like a pun).

Below, and on the left of the *Galium*-seed, are some spicules of the *Hymedesmia*, a sponge which is found on the coast of Madeira. The following account of it occurs in the *Intellectual Observer*, vol. ii. p. 312:—

“Fish-hook Spiculæ.—We have received from Mr. Baker, of Holborn, a slide containing spicules of the *Hymedesmia Johnsonii*, which are stated to be rare objects in this country. They have the form of a double fish-hook, and on the inner surface of

each hook is an extremely sharp knife-edge projection, corresponding with a similar and equally sharp projection from the inside of the shank.”

“These minute knife-blades are so arranged that in addition to their cutting properties, they would act as barbs, obstructing the withdrawal of the hook. The two hooks attached to one shank are not in the same place, but nearly at right angles with one another, so that when one is horizontal the other is vertical, or nearly so. A magnification of four or five hundred linear does not in any way detract from the sharp appearance of the knife-edges, and they may take their place with the anchors of the Synapta as curious illustrations of the occurrence in living organisms of forms which man was apt to fancy were exclusively the products of his own contrivance and skill.

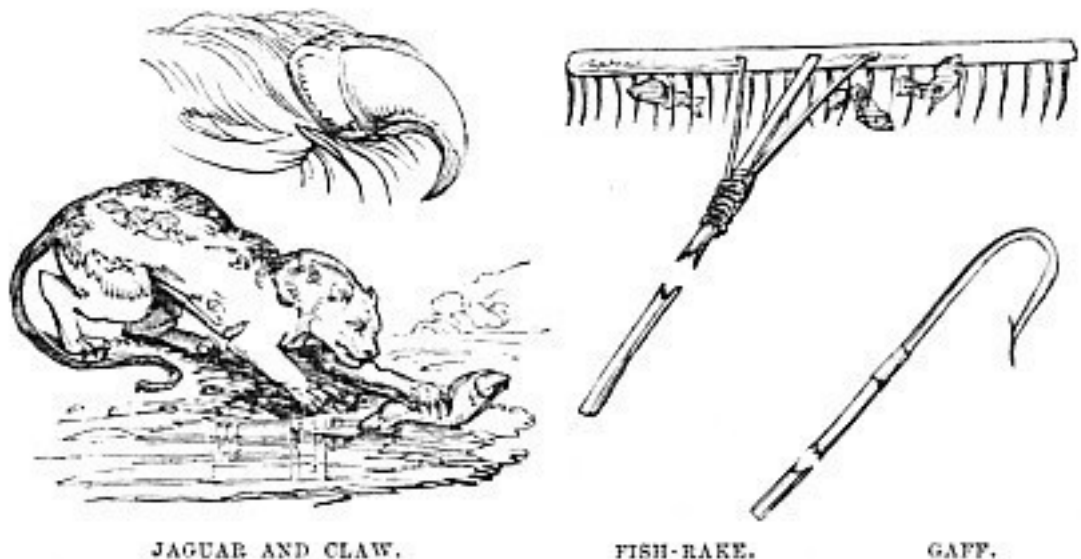
“We presume that these hooks of the Hymedesmia answer the usual purpose of spiculæ in strengthening the soft tissue, but they must likewise render the sponge an awkward article for the Madeira sea-slugs to eat.”

For an account and figures of the Synapta anchor-spicules see page 39.

We now come to another modification of the hook. I presume that many of my readers have heard of the practice called “snatching” fish, though I hope that they have never been unsportsmanlike enough to follow it.

This plan, which is only worthy of poachers, consists in taking several flights of treble or quadruple hooks, dropping them gently by the side of the fish, and then, with a sudden jerk, driving them into any part of its body which they may happen to strike. Most anglers have snatched fish accidentally, but to do so intentionally is ranked among the worst of an angler’s crimes, and is equivalent to cheating at cards, or playing with false dice.

In some parts of the world, however, there are certain small fish which are never taken in any other way, and, indeed, are raked out of the water just as a gardener rakes dead leaves off the path or beds.



In British Columbia there are certain lakes tenanted largely with small fish which form a considerable portion of the natives’ diet. They swim in vast shoals close to the surface of the water, and are captured by veritable rakes, one of which is shown in the illustration. The points of the rake are slightly curved, and very sharp, and so numerous are the fish that when the native has struck his rake among the shoal, and drawn it into the boat, he generally finds a fish on every tooth, while it

often happens that two or three are transfixed by the same tooth. A sharp knock against the side of the boat shakes off the prey, and the fisherman again strikes his rake into the shoal. By this simple mode of fishing a couple of men will, in a few hours, load a canoe with small but valuable fish.

Below the rake is the “Gaff,” an instrument, not to say a weapon, which is indispensable when salmon or other large fish are to be caught. For ordinary-sized fish a landing-net is sufficient, but no landing-net could either receive or retain a salmon of any size.

Recourse is then had to the Gaff, which is simply a huge hook at the end of a handle. The fish being “played” until it can be drawn within reach, the gaff is slipped under it, struck into the side of the salmon, and by its aid the fish is easily lifted out of the water.

On the left hand of the illustration are two figures showing how the principle of the fish-rake and gaff has been anticipated in Nature.

It is a well-known fact that the Jaguar feeds largely on fish, which it catches for itself. It goes down to the river-side as close to the water as possible, and waits patiently for its prey. As soon as a fish comes within reach, the Jaguar stretches out its paw to the fullest extent, and, with a stroke of the curved claws, hooks the fish on shore, just as the Vancouver Islander does with his fish-rake, or the English angler with his gaff.

Many persons have practically experienced the gaff-like powers of the feline claw by the loss of their gold-fish. It is seldom safe to leave a globe of gold-fish within reach of a cat. Nearly all cats are madly fond of fish, and, in spite of their instinctive hatred of water, will hook out the fish with their claws, and eat them. Indeed, there are several instances on record where a cat has regularly caught fish, and brought them home to its owner. Mr. F. Buckland gives an account of a fisherman's cat, which used to go out with her master, jump into the sea, secure a fish, and then be lifted on board with her prey.

Above the Jaguar is drawn a single claw, so as to show the form of the instrument by which the fish is captured.

Armour

We will now take the subject of Defensive Armour, by which warriors are enabled to protect themselves against the offensive weapons of the enemy.

As many readers will probably know, armour reached its greatest development in the Middle Ages, when the knight was so completely cased in steel that no weapon then in use could penetrate his panoply.

The head, body, and limbs were covered with steel plates curiously articulated at the joints, so as to give freedom of motion, while guarding the wearer from any ordinary weapon. A warrior might be beaten from his horse by a mace, or struck down by a lance, or the horse itself might be killed under him.

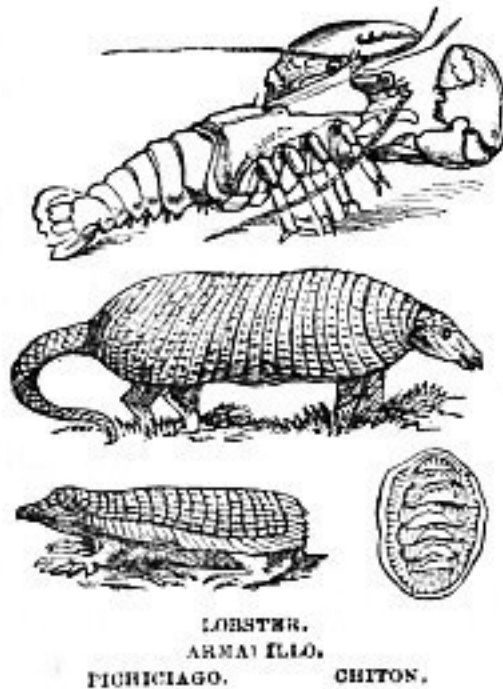


PLATE AND SCALE ARMOUR
OF MIDDLE AGES.

In either of these cases the fallen knight was not much the worse, until a weapon called the “Misericorde,” or dagger of mercy, was invented. This was a poniard with a very slender and very sharp blade, so constructed that it could be driven between the joints of the armour, and thus inflict a mortal wound. The Misericorde, however, was baffled by the use of chain or scale armour under the plate-mail, and then the only way of getting at the fallen knight was by breaking up the armour with hammers which were made for this express purpose.

Perhaps the reader may wonder that any one should lie quietly and allow himself to be so badly treated. The very strength of the armour, however, which rendered its wearer unassailable by ordinary weapons, involved so much weight, that when a knight had fallen, it was impossible for him to rise, much less to mount a horse, without help. Moreover, the first blow of a weighty hammer on the helmet would, although it could not kill the wearer, cause such a jar to his brain as partially, if not wholly, to stun him.

The rapidly increasing power of firearms soon caused armour to be laid aside, and now the only remains of it are to be found in the helmets and cuirasses worn by our dragoons.

There are few parts of the world where armour of some sort is not used. Putting aside civilised or semi-civilised nations, we find that in most cases, wherever there is war, there is armour of some kind. Sometimes it is movable, and in that case is called a shield.

The most singular shields that I know are those made by the Australians, which are so shaped that no one who did not know their use would take them for shields. They are about three feet long, four inches wide at the back, six inches or so thick in the middle, tapering towards the ends, and coming to an edge in front. They are held by the centre with one hand, so that they can be rapidly twisted from side to side, and so serve to parry the spear or stop the boomerang. The weight of the shield enables it to withstand the shock of the boomerang, which whirls through the air with terrific force.

Several warlike savage tribes have, however, no armour of any kind, such as the New Zealanders, the Samoans, and the Fijians.

Sometimes the armour is affixed to the body, and of such protection many examples are to be found in various museums, among which the Christy collection is pre-eminent.

Among the Polynesians cocoa-nut fibre was at one time employed as the material for armour. It was twisted into small cords, and with these a sort of armour was constructed, quite strong enough to resist any weapon that an enemy of their own kind could bring against them. Sometimes this armour was merely a belt wide enough to protect the abdomen, but sometimes the whole body was defended, from the neck to the hips.

In the United Service Museum there is a very remarkable cuirass, which is made of successive rows of seals' teeth, each row overlapping the other like the tiles of a house. It is very heavy, weighing quite as much as a steel cuirass, and was probably quite as effective against the primitive weapons which could be brought to bear upon it.

Now for Natural Armour.

There are so many examples of armour, as furnished by Nature, that I can only mention a few.

Any one who looks at a lobster, crayfish, prawn, or shrimp, must at once see that in it lies the prototype of plate armour. That portion of the lobster which is popularly called the head, and is scientifically known as the "carapace," is not jointed, and corresponds with the cuirass of ancient or modern armour. Then comes the part called the "tail," the joints of which are exactly like those employed in the shoulders, elbows, knees, and ankles of ancient armour. The lobster tail will again be mentioned in connection with another branch of human art.

As for the heavy, ungraceful armour which was used in tilting, we have an admirable example in the Trunk-fish of the tropical seas (*Ostracion*), the whole of which is enclosed in a bony case, the fins and tail protruding through openings in it. In fact, the scales, instead of being separate, are fused together so as to form a continuous covering. The Box-tortoise of South America is another good example, the creature being furnished with bony flaps with which it covers the apertures through which the head, legs, and tail are protruded, and so is as impervious as the knight of old.

In the later ages of armour, the thighs, instead of being enclosed in steel coverings with cuisses, were defended by a number of steel plates called "tassets." Now these tassets are exactly like the defensive armour of the Armadillo's back, and, though it is not likely that the inventor of tassets should have seen an Armadillo, the fact still remains, that Art has been anticipated by Nature.

Exactly the same principle is seen in that wonderful little animal, the Pichichiago of South America, which is shown in the lower left-hand figure of the illustration. This creature is not only furnished with bony rings on the body like those of the Armadillo, but has likewise a flap which comes over the hindquarters, and effectually defends it against the attacks of any foe that might pursue it into its burrow.

In the lower right-hand corner of the illustration is seen a figure of a Chiton, several species of which are common on most of our coasts. This is one of the molluscs, which adheres to the rock just as limpets do. But, whereas the shell of the limpet is all in one piece and inflexible, that of the Chiton is composed of several pieces, which are arranged exactly like the tassets of armour, and enable the Chiton to accommodate itself to the inequalities of the rocks to which it is adhering.

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