

To measure the Number of Cubic Feet of Water conveyed by a River in each Second.

THE data required are—the area of the river-section and the average velocity of the whole of the current. All that a traveller is likely to obtain, without special equipment, is the area of the river-section and the average velocity of the *surface* of the current, which differs from that of its entire body, owing to frictional retardation at the bottom.

To make the necessary measurements, choose a place where the river runs steadily in a straight and deep channel, and where a boat can be had. Prepare half-a-dozen floats, of dry bushes with paper flags, and be assured they will act. Post an assistant on the river-bank, at a measured distance (of about 100 yards) down stream, in face of a well-marked object. Row across stream in a straight line, keeping two objects on a line in order to maintain your course. Sound at regular intervals from shore to shore, fixing your position on each occasion, by a sextant-angle between your starting-place and your assistant's station, and throw the floats overboard, signalling to your assistant when you do so, that he may note the interval that elapses before they severally arrive opposite to him. Take an angle from the opposite shore, to give the breadth of the river.

To make the calculation approximately, protract the section of the river on a paper ruled to scale in square feet, and count the number of squares in the area of the section. Multiply this by the number of feet between you and the assistant, and divide by the number of seconds that the floats occupied, on an average, in reaching him.

Important rivers should always be measured above and below their confluence; for it settles the question of their relative sizes, and throws great light on the rainfall over their respective basins. The sectional area at the time of highest water, as shown by marks on the banks, ought also to be ascertained.

1 *Hints on the Collection of Objects of Natural History.*

By H. W. BATES, Assistant Secretary R.G.S.

TRAVELLERS who intend devoting themselves specially to Natural History will generally possess all the requisite information beforehand. It is to those whose objects or duties are of another nature, or who, whilst on a purely geographical land-exploration, wish to know the readiest means of collecting, preserving, and safely transmitting specimens they collect that the following hints are addressed:—

Outfit.—Double-barrel guns, with spare nipples; and a few common guns to lend to native hunters—especially if going to the interior of Tropical America.

Fine powder in canisters, and fine shot (Nos. 8 and 11), must be taken from England: coarse powder and shot can be had in any part. A good supply of the best caps.

Arsenical soap, a few pounds in tin cases; brushes of different sizes.*

Two or three scalpels, scissors (including a pair of short-bladed ones), forceps of different sizes, for inserting cotton into the necks of birds' skins; needles and thread.

A few small traps, with which to capture small (mostly nocturnal) mammals.

Strong landing-net for water mollusks, &c. Two stout insect *sweeping-nets*.

Cylindrical tin box for collecting plants, with shoulder-strap.

A few dozens of small and strong broad-mouthed bottles; and a couple of corked pocket-boxes.

Insect-pins: a few ounces each of Nos. 5, 14, and 11.

Stone jars for reptiles and fishes in spirit; to fit four in a box, with wooden partitions. If animals in spirit are to be collected largely, a supply of sheet-tin or zinc, with a pair of soldering-irons and a supply of soft solder, must be taken instead of stone jars. Cylindrical cases can be then made of any size required. By means of the soldering apparatus, also, empty powder-canisters and other tin vessels can be easily converted into receptacles for specimens.

A ream or two of botanical drying-paper, with boards of same size as the sheet, and leather straps.

A few gross of chip pill-boxes in nests.

A dozen corked store-boxes (about 14 inches by 11 inches, and 2½ inches deep,) fitted perpendicularly in a tin chest.

A few yards of india-rubber waterproof sheeting, as temporary covering to collections in wet weather, or in crossing rivers.

A set of carpenter's tools.

An outfit may be much lightened by having all the provisions and other consumable articles packed in square tin cases, and in

* Most of the articles of a Naturalist's outfit can be obtained, at a few days' notice, of Mr. S. Stevens, Natural History Agent, 24, Bloomsbury-street, W.C.

boxes and jars of such forms as may render them available for containing specimens. If the traveller is going to the humid regions of the Indian Archipelago, South-eastern Asia, or Tropical America, where excessive moisture, mildew, and ants, are great enemies to the naturalist, he should add to his outfit two drying-cages; for everything that is not put at once into spirits is liable to be destroyed before it is dry enough to be stowed away in boxes. They may be made of light wood, so arranged as to take to pieces and put together again readily; one, for birds, should be about 2 feet 6 inches long by 1 foot 6 inches high and 1 foot broad; the other, for insects and other small specimens, may be about one-third less. They should have folding doors in front, having panels of perforated zinc, and the backs wholly of the latter material; the sides fitted with racks to hold six or eight plain shelves, which, in the smaller cage, should be covered with cork or any soft wood that may be obtained in tropical countries. A strong ring fixed in the top of the cage, with a cord having a hook attached at the end by which to hang it in an airy place, will keep the contained specimens out of harm's way until they are quite dry, when they may be stowed away in close-fitting boxes. If this plan be not adopted, it will be almost impossible to preserve specimens in these countries.

Collecting.—The countries which are now the least known with regard to their Natural History, are New Guinea, and the large islands to the east of it, Northern Australia, the interior of Borneo, Thibet, and other parts of Central Asia, Equatorial Africa, and the eastern side of the Andes from east of Bogota to the south of Bolivia. In most of the better known countries the botany has been better investigated than the zoology, and in most countries there still remains much to be done in ascertaining the exact station, and the range, both vertical and horizontal, of known species. This leads us to one point, which cannot be too strongly insisted on, namely, that some means should be adopted by the traveller to record the exact locality of the specimens he collects. In the larger dried animals, this may be done by written tickets attached to the specimens; in pinned insects, a letter or number may be fixed on the pins of all specimens taken at one place and time—the mark to refer to a note-book. The initial letter, or first two or three letters of the locality, is perhaps the readiest plan; and when all the specimens taken at one place can be put into a separate box, one memorandum upon the box itself will be sufficient. Reptiles and fishes can have small parchment tickets attached to them before placing in spirits.

A traveller may be puzzled, in the midst of the profusion of animal and vegetable forms which he sees around him, to know what to secure and what to leave. Books can be of very little

service to him on a journey, and he had better at once abandon all idea of encumbering himself with them. A few days' study at the principal museums before he starts on his voyage may teach him a great deal, and the cultivation of a habit of close observation and minute comparison of the specimens he obtains will teach him a great deal more. As a general rule, all species which he may meet with for the first time far in the interior, should be preferred to those common near the civilized parts. He should strive to obtain as much variety as possible, and not fill his boxes and jars with quantities of specimens of one or a few species. But, as some of the rarest and most interesting species have great resemblance to others which may be more common, he should avail himself of every opportunity of comparing the objects side by side. In most tropical countries the species found in open and semi-cultivated places are much less interesting than those inhabiting the interior of the forests, and it generally happens that the few handsome kinds which attract the attention of the natives are species well known in European museums. In botany, a traveller, if obliged to restrict his collecting, might confine himself to those plants which are remarkable for their economical uses; always taking care to identify the flowers of the tree or shrub whose root, bark, leaves, wood, &c., are used by the natives, and preserving a few specimens of them. But, if he is the first to ascend any high mountain, he should make as general a collection of the flowering plants as possible, at the higher elevations. The same may be said of insects found on mountains, where they occur in very great diversity—on the shady and cold sides rather than on the sunny slopes—under stones, and about the roots of herbage especially near springs, on shrubs and low trees, and so forth; for upon a knowledge of the plants and insects of mountain ranges depend many curious questions in the geographical distribution of forms over the earth. In reptiles, the smaller *Batrachia* (frogs, salamanders, &c.) should not be neglected, especially the extremely numerous family of tree-frogs; lizards may be caught generally with the insect sweeping-net; the arboreal species seen out of reach may be brought down with a charge of dust-shot. Snakes should be taken without injuring the head, which is the most important part of the body; a cleft stick may be used in securing them by the neck, and on reaching camp they may be dropped into the jars of spirits. As large a collection as possible should be made of the smaller fishes of inland lakes and unexplored rivers; Dr. Gunther, of the British Museum, has authorised me to say that a traveller cannot fail to make a large number of interesting discoveries if he collects a few specimens of the species he meets with in the lakes and rivers of the interior of any country.

It can scarcely be expected that specimens of the larger animals can be brought away by a geographical expedition, although some species are still desiderata in the large museums of Europe. Additional specimens of all genera, of which there are numerous closely-allied species (*e. g.* rhinoceros, antilope, equus, &c.) would be very welcome for the better discrimination of the species. If only portions can be obtained, skulls are to be preferred. In humid tropical regions entire skins cannot be dried in time to prevent decay, and it is necessary to place them, rolled up in small compass, in spirits. The smaller mammals, of which there remain many to reward the explorer in almost all extra-European countries, may be skinned, dried, and packed in boxes in the same manner as birds. The smaller birds shot on an excursion should be carried to camp in the game-bag, folded in paper, the wounds, mouth, and anus being first plugged with cotton. Powdered calcined gypsum will here be found very useful in absorbing blood from feathers, on account of the facility with which it can be afterwards cleared from the specimens. All plants, when gathered, are placed in the tin box which the traveller carries with him. Land and fresh-water shells may be carried home in a bag. All hard-bodied insects, such as beetles, ants, and so forth, should be placed, in collecting, in small bottles; each bottle having a piece of slightly-moistened rag placed within it, to prevent the insects from crowding and injuring each other. The hint previously given with regard to number of specimens must be repeated here. *Take as great a variety of species as possible.* The sweeping-net should be freely used (except in very wet weather) in sweeping and beating the herbage and lower trees. In collecting ants, it is necessary to open nests and secure the winged individuals of each species, which must be afterwards kept together with the wingless ones to secure the identification of the species. Bees and wasps may be caught in the net and then placed by means of small forceps in the collecting-bottle and afterwards killed in the same way as beetles and other hard-bodied insects. All soft-bodied insects should be killed on capture (by a slight pressure of the chest underneath the wings by thumb and finger) and then pinned in the pocket collecting-box. If the traveller has leisure and inclination for the pursuit, he may readily make a large and varied collection of these, and will do good service to science if he notes carefully the exact localities of his captures, altitude above the sea, nature of country, the sexes of the species (if detected), and information on habits. The delicate species should be handled very carefully and put away into the drying-cage immediately on return from an excursion. Spiders may be collected in bottles, and afterwards killed and pinned in the same way as other insects. Crustacea (shrimps, crawfish, &c.) in rivers and pools may be col-

lected with the landing-net and afterwards well dried and pinned like hard-bodied insects, except when they are large in size, when their bodies must be opened and emptied of their contents.

Preserving and Packing.—Previous to skinning a small mammal or bird, make a note of the colour of its eyes and soft parts, and, if time admits, of the dimensions of its trunk and limbs. It facilitates skinning of birds to break, before commencing, the first bone of the wings a short distance above the joint, which causes the members to lie open when the specimen is laid on its back on the skinning-board. The animal should be laid with its tail towards the right hand of the operator, and the incision made from the breast-bone nearly to the anus. A blunt wooden style is useful in commencing the operation of separating the skin from the flesh. When the leg is reached, cut through the knee-joint and then clear the flesh from the shank as far as can be done, afterwards washing the bone slightly with arsenical soap, winding a thin strip of cotton round it and returning it to the skin. Repeat the process with the other leg, and then sever with the broad-bladed scissors the spine above the root of the tail. By carefully cutting into the flesh from above, the spine is finally severed without injuring the skin of the back, and it is then easy to continue the skinning up to the wings, when the bones are cut through at the place where they had previously been broken and the body finished as far as the commencement of the skull. A small piece of the skull is now cut away, together with the neck and body, and the brains and eyes scooped out, the inside washed with the soap, and clean cotton filled in, the eyes especially being made plump. In large-headed parrots, woodpeckers, and some other birds, the head cannot thus be cleaned; an incision has, therefore, to be made either on one side or on the back of the neck, through which the back of the skull can be thrust a little away and then cleaned, the incision being afterwards closed by two or three stitches. The bones then remaining in each wing must be cleaned, which must be done without loosening the quill-feathers. It is much better to take out the flesh by making an incision on the outside of the skin along the flesh on the inner side of the wing. The inside of the skin must now be washed with the soap, and a neck of cotton (not too thick) inserted by means of the long narrow forceps, taking care to fix the end well inside the skull and withdrawing the empty forceps, without stretching the skin of the neck and thus distorting the shape of the bird. Skins need not be filled up with cotton or any other material, but laid, with the feathers smoothed down, on the boards of the drying-cage until they are ready to be packed in boxes. In very humid climates, like that of Tropical America, oxide of arsenic in powder is preferable to arsenical soap, on account of the skins drying quicker; but it cannot be recommended to the general traveller, owing to the danger attending its use.

In mammals the tail offers some difficulty to a beginner. To skin it, the root (after severing it from the spine) should be secured by a piece of strong twine, which should then be attached to a nail or beam; with two pieces of flat wood (one placed on each side of the naked root), held firmly by the hand and pulled downwards, the skin is made rapidly to give way generally to the tip. The tails of some animals, however, can be skinned only by incisions made down the middle from the outside. The larger mammal skins may be inverted, and, after washing with the soap, dried in the sun: as before remarked, it is often necessary to roll them up and preserve in spirit.

The skins of small mammals and birds, after they are *quite* dry, may be packed in boxes, which must be previously well washed inside with arsenical soap, lined with paper and again covered with a coating of the soap and well dried in the sun. This is the very best means of securing the specimens from the attacks of noxious insects, which so often, to the great disgust of the traveller, destroy what he has taken so much pains to procure. Where wood is scarce, as in the interior of Africa, boxes may be made of the skins of antelopes or other large animals by stretching them, when newly stripped from the animal, over a square framework of sticks, and sewing up the edges; after being dried in the sun they make excellent packing-cases.

With regard to reptiles and fishes, I cannot do better than quote the following remarks sent to me by Mr. Osbert Salvin, who collected these animals most successfully in Guatemala:—

“Almost any spirit will answer for this purpose, its fitness consisting in the amount of alcohol contained in it. In all cases it is best to procure the strongest possible, being less bulky, and water can always be obtained to reduce the strength to the requisite amount. When the spirit sold retail by natives is not sufficiently strong, by visiting the distillery the traveller can often obtain the first runnings (the strongest) of the still, which will be stronger than he requires undiluted. The spirit used should be reduced to about proof, and the traveller should always be provided with an alcoholometer. If this is not at hand, a little practice will enable him to ascertain the strength of the spirit from the rapidity with which the bubbles break when rising to the surface of a small quantity shaken in a bottle. When the spirit has been used this test is of no value. When animals or fish are first immersed, it will be found that the spirit becomes rapidly weaker. Large specimens absorb the alcohol very speedily. The rapidity with which this absorption takes place should be carefully watched, and in warm climates the liquid tested at least every twelve hours, and fresh spirit added to restore it to its original strength. In colder climates it is not requisite to watch so closely, but practice

will show what attention is necessary. It will be found that absorption of alcohol will be about proportionate to the rate of decomposition. Spirit should not be used too strong, as its effect is to contract the outer surface, and thus, closing the pores, prevent the alcohol from penetrating through to the inner parts of the specimen. *The principal point, then, is to watch that the strength of the spirit does not get below a certain point while the specimen is absorbing alcohol when first put in.* It will be found that after two or three days the spirit retains its strength: when this is the case, the specimen will be perfectly preserved. Spirit should not be thrown away, no matter how often used, so long as the traveller has a reserve of sufficient strength to bring it back to its requisite strength.

“In selecting specimens for immersion, regard must be had to the means at the traveller’s disposal. Fish up to 9 inches long may be placed in spirit, with simply a slit cut to allow the spirit to enter to the entrails. With larger specimens, it is better to pass a long knife outside the ribs, so as to separate the muscles on each side of the vertebræ. It is also as well to remove as much food from the entrails as possible, taking care to leave all these in. The larger specimens can be skinned, leaving, however, the intestines in, and simply removing the flesh. Very large specimens preserved in this way absorb very little spirit. All half-digested food should be removed from snakes and animals. In spite of these precautions, specimens will often appear to be decomposing; but by more constant attention to re-strengthening the spirit they will, in most cases, be preserved.

“A case (copper is the best), with a top that can be unscrewed and refixed easily, should always be carried as a receptacle. The opening should be large enough to allow the hand to be inserted; this is to hold freshly-caught specimens. When they have become preserved, they can all be removed and soldered up in tin or zinc boxes. Zinc is best, as it does not corrode so easily. The traveller will find it very convenient to take lessons in soldering, and so make his own boxes. If he takes them ready made, they had best be arranged so as to fit one into another before they are filled. When moving about, all specimens should be wrapped in calico or linen or other rags to prevent their rubbing one against the other. This should also be done to the specimens in the copper case when a move is necessary, as well as to those finally packed for transmission to Europe. These last should have all the interstices between the specimens filled in with cotton-wool or rags. If a leak should occur in a case, specimens thus packed will still be maintained moist and will keep some time without much injury. Proof spirit should be used when the specimens are finally packed, but it is not necessary that it should be fresh.”

Land and fresh-water shells, on reaching camp, should be placed in a basin of cold water to entice the animals out, and then, after draining off, killed by pouring boiling water over them. They may be cleared of flesh by means of a strong pin or penknife. The operculum or mouthpiece of all shells which possess it should be preserved and placed inside the empty shell. Each shell, when dry, should be wrapped in a piece of paper and the collection packed in a box, well padded with cotton or other dry and elastic material.

The insects collected on an excursion should be attended to immediately on arrival in camp. When leisure and space are limited, all the hard-bodied ones may be put in bottles of spirit; and each bottle, when nearly full, should be filled up to the cork with a piece of rag, to prevent injury from shaking. Many species, however, become stained by spirit, and it is far better in dry countries, such as Africa, Australia, and Central Asia, to preserve all the hard-bodied ones in a dry state in pill-boxes. They are killed, whilst in the collecting-bottles, by plunging, for a few moments, the bottom half of the bottles in hot water. An hour afterwards the contents are shaken out over blotting-paper and put into pill-boxes; the bottom of the boxes being padded with cotton, over which is placed a circular piece of blotting-paper. The open pill-boxes should then be placed in the drying-cage for a day or two and then filled up with more cotton, the layer of insects being first covered by a circular piece of paper.* The soft-bodied specimens, which are brought home pinned, should be stuck in the drying-cage until they are dry, and then be pinned very close together in the store-boxes. The store-boxes, both bottom and sides, should each have inside a coating of arsenical soap before they are corked, and as they become filled, one by one, should be washed outside with the soap and pasted all over with paper. Camphor and other preservatives are of little or no use in tropical climates. In some countries where the traveller may wish to make a collection of the butterfly fauna, the best way is to preserve all the specimens in little paper envelopes. He should be careful not to press the insects too flat, simply killing them by pressure underneath the breast, folding their wings carefully backwards and slipping them each into its envelope. In very humid tropical countries, such as the river valleys of Tropical America and the islands of the Eastern Archipelago, the plan of stowing away even hard-bodied insects in pill-boxes does not answer, on account of the mould with which they soon become covered. There are, then, only two methods that can be adopted: one preserving them at

* The only preservative needed is a diluted wash of arsenical soap inside the pill-boxes, which, as in all other cases when soap is used, must be well dried afterwards, before the boxes are filled.

once in spirits, the other pinning all those over a quarter of an inch long (running the pin through the right wing-case so as to come out beneath, between the second and third pair of legs); and gumming those of smaller size on small sheets of card, cut of uniform size so as to fit perpendicularly in racked boxes, like those used to contain microscopical slides, but larger. The cards may be a few inches square, and each may hold several scores of specimens, very lightly gummed down a short distance apart. After the cards are filled they should be well dried, and the box containing them washed outside with arsenical soap and pasted over with paper. All the pinned specimens should be placed to dry for a few days in the drying-cage, and afterwards pinned very close together in the corked store-boxes.

Plants are dried by pressure, by means of the boards and straps, between sheets of botanical drying-paper—the paper requiring to be changed three or four times. When dry, the specimens may be placed between sheets of old newspapers, together with the notes the traveller may have made upon them, each placed upon the object to which it refers. Bundles of papers containing plants are not of difficult carriage; but they require to be guarded against wet, especially in fording rivers and in rainy weather, and should be wrapped in skins or india-rubber sheeting until they can be safely packed in wooden boxes and despatched to Europe. Seeds may be collected when quite ripe and preserved in small packets of botanical paper, with a number written on referring to preserved specimens of the flowers. Dry fruits and capsules should be collected when in countries not previously explored by botanists, if the traveller has means of identifying the species to which they belong.

Fossils.—The collection of fossils and minerals (except in the case of the discovery of new localities for valuable metals) is not to be recommended to the traveller, if he is not a Geologist. Fossils from an unexplored country are of little use unless the nature and order of superposition of the strata in which they are found can be at the same time investigated. In the cases, however, of recent alluvial strata, or the supposed beds of ancient lakes, or deposits in caves, or raised sea-beaches containing shells or bones of vertebrate animals, the traveller will do well to bring away specimens if a good opportunity offers. If the plan of the expedition includes the collection of fossil remains, the traveller will, of course, provide himself with a proper geological outfit and obtain the necessary instructions before leaving Europe.

All collections made in tropical countries should be sent to Europe with the least possible delay, as they soon become deteriorated or spoilt unless great care be bestowed upon them. Dry skins of animals and birds may be packed in wooden cases simply

with sheets of paper to separate the skins. Shells and skulls should be provided with abundance of elastic padding, such as cotton. The boxes containing insects and crustacea should be placed in the middle of large boxes surrounded by an ample bed of hay or other light dry elastic material: if this last point be not carefully attended to, it will be doubtful whether such collections will sustain a voyage without much injury.

Travellers have excellent opportunities of observing the habits of animals in a state of nature, and these hints would be very deficient were not a few words said upon this subject. To know what to observe in the economy of animals is in itself an accomplishment which it would be unreasonable to expect the general traveller to possess, and without this he may bring home only insignificant details, contributing but little to our stock of knowledge. One general rule, however, may be kept always present to the mind, and this is, that anything concerning animals which bears upon the relations of species to their conditions of life is well worth observing and recording. Thus, it is important to note the various enemies which each species has to contend with, not only at one epoch in their lives, but at every stage from birth to death, and at different seasons and in different localities. The way in which the existence of enemies limits the range of a species should also be noticed. The inorganic influences which inimically affect species, especially intermittently (such as the occurrence of disastrous seasons), and which are likely to operate in limiting their ranges, are also important subjects of inquiry. The migrations of animals, and especially any facts about the irruption of species into districts previously uninhabited by them, are well worth recording. The food of each species should be noticed, and if any change of customary food is observed, owing to the failure of the supply, it should be carefully recorded. The use in nature of any peculiar physical conformation of animals, the object of ornamentation, and so forth, should also be investigated whenever opportunity occurs. Any facts relating to the interbreeding in a state of nature of allied varieties, or the converse—that is, the antipathy to intercrossing of allied varieties—would be extremely interesting. In short, the traveller should bear in mind that facts having a philosophical bearing are much more important than mere anecdotes about animals.

To observe the actions of the larger animals, a telescope or opera-glass will be necessary; and the traveller should bear in mind that if a microscope is ever needed in his journey, that by unscrewing the small tubes of the telescope a compound microscope of considerable power is produced.