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The
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WHEN writing in the June, 1939, *Salmon and Trout Magazine* on Nymph Fishing on Chalk Streams, I was in some doubt as to the mechanism by which air or gas entered the nymphal envelope in order to effect the liberation of the subimago.

Since then, I have had the opportunity of meeting a distinguished American entomologist, Dr. H. T. Spieth, who visited the Natural History Museum for the purpose of studying its Ephemeroptera collections. He is a specialist in this group.

Far more work has been carried through in America than in this country in the study of the life history of various insects, and, as it will be of interest to fly-fishers to understand the method of emergence of the dun, since it has some bearing on the practice of nymph fishing, I took the opportunity of asking Dr. Spieth what was known about the subject in his country.

He told me that the method of emergence in the Ephemeroptera is generally accepted by entomologists as being the same as that of the cockroach, an insect which has a similar metamorphosis, that is, there is a nymphal phase from which the mature insect emerges without any intervening resting period such as occurs in the caddis fly and Lepidoptera.

Close and accurate observations have been made in regard to the cockroach, and it has now been definitely established that at some period before the final moult, the intestinal canal is broken in two places. The upper and lower portions of the intestinal lining of the nymph are withdrawn and left behind in the nymphal envelope, the middle portion remaining in the

intestine of the adult insect from which it is subsequently ejected. Observation of cast skins of Ephemeropterid nymphs has shown that these two portions of the lining are also left behind in this Order.

It would appear that the breaking loose of the adult cockroach or the Ephemeropterid subimago is absolutely dependent on the introduction of air into the intestines from which it passes round the body of mature insect and frees it from the nymphal skin.

The actual manner is as follows. Air is taken in through the mouth, and it may be remembered that in the Salmon and Trout article, I quoted the American specialist, Miss Anna Morgan, as stating that she had observed Ephemeropterid nymphs putting their mouths out of the water and gulping in air. The air passes down into the intestine of the nymph and escapes through the upper fracture into the intestine of the subimago. As more and more air is swallowed, it is forced up between the nymphal intestinal lining and that of the subimago, separating the two until finally it emerges through the mouth of the latter which is sealed by the nymphal skin. The pressure increases and the air continues to force a passage down and round the subimago until at last it is completely separated from the nymphal skin and Halford's "loose envelope" is formed.

It would appear, therefore, that the liberation of the subimago from the nymphal envelope can begin only when the nymph has arrived at the surface and has direct access to the air. It is also obvious that the process of this liberation will occupy a considerable time as has, indeed, been shown by aquarium observation.

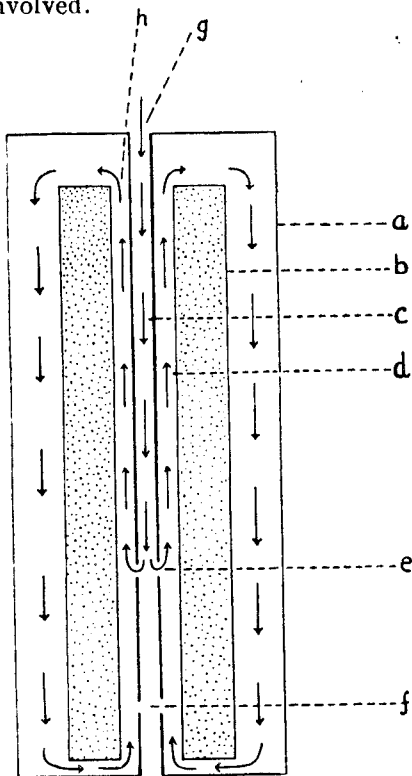
The difficulty of maintaining observation from the bank on a nymph in its natural environment, carried down by the current at the rate of two to three miles an hour, is self evident.

Those anglers who have received the impression that they have seen a nymph swim to the surface and immediately trans-

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form into the subimago have, no doubt, unwittingly deceived themselves and have taken the visible emergence of the thorax of the subimago above the surface for the first appearance there of the nymph. Probably, to the angler from the bank, or even wading in the stream, nymphs struggling in the water film, with no part protruding above its surface, are practically invisible against the background of the river bed.

It may, perhaps, be helpful if I give a diagrammatic figure of the mechanism involved.



(a) skin of the nymph; (b) skin of the subimago; (c) intestine of the nymph; (d) intestine of the subimago; (e) upper fracture of the nymphal intestine; (f) lower fracture of the nymphal intestine; (g) mouth of the nymph; (h) mouth of the subimago.

The arrows indicate the passage of the air.

If these observations on the liberation of the cockroach (or nymph) are accurate, then it is evident that the agent is simply air and not a gas, air that can only be obtained when the nymph is at the surface, and this appears to dispose, once and for all, of the theory that the nymph is floated up from the bottom by the agency of this air.

