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Insects in marine environments

Lanna Cheng

Insects now comprise over 75 % of all described animal species and exhibit not only a rich variety of form, colour and shape, but also a range of ecological adaptations unexcelled by any other group. Nevertheless, they have generally failed to establish themselves in the world's seas and oceans. Some speculations as to why insects are so rare in marine habitats have been based on a single postulated obstacle, such as the low concentrations of calcium in seawater (Pruthi, 1932, refuted by Thorpe, 1932). Others have been based on a complex combination of biological, physical and chemical factors (Carpenter, 1901; Walsh, 1925; Buxton, 1926; MacKerras, 1950; Usinger, 1957). How such factors may have operated to exclude most of an otherwise highly successful group of animals from the most extensive biotope on earth is still not understood.

Actually, some insects are associated with the sea. Even on the open ocean, thousands of kilometres from land, we can find *Halobates*, which, however, spends all its life on the sea surface. As far as we know, no marine insects remain submerged throughout their lives. (The report that *Pontomyia* (Chironomidae) is permanently submarine (Edwards, 1926) is erroneous (Tokunaga, 1932).)

About 3 %, some 25,000 to 30,000 species of insects, are aquatic or have aquatic larval stages. Of these only a fraction, perhaps several hundred species, are marine or intertidal. Nevertheless, certain marine insects are of considerable economic or medical importance. Man's progress and the development of millions of acres of coastal land around the world have been impeded by saltmarsh mosquitoes, midges and tabanid flies (see Chs 12, 13 and 15), some of which not only bite man but may also carry human diseases. Many beaches are at times rendered unsuitable for recreation because of an abundance of these biting insects, or of various seaweed flies or beach flies (see Chs 16 and 17) which, though they do not bite, may occur in such large numbers (hundreds of thousands per kilometre) that they constitute quite a nuisance. Although we have considerable information on saltmarsh mosquitoes and midges, especially those aspects relevant to the control of these pests, our knowledge of the basic biology, physiology and adaptations of even the most intensively studied species is still far from adequate.

Marine insects have generally been ignored in standard entomological books on the one hand, and in marine invertebrate books on the other. However, several lists of marine insects have been compiled (Backlund, 1945; Marine Biological Association, 1957; Smith and Carlton, 1975; etc.). Such lists are generally regional and far from complete, but they do indicate the existence of potentially rich faunas of coastal marine insects that are often overlooked.

According to the fossil record, land insects, along with vascular plants, arose in the Mid-Palaeozoic some 250–300 million years ago, when the seas were shallow, extensive, warm, and already populated by virtually all major phyla of marine invertebrates which had evolved some 200 million years earlier. The first winged insects probably became established in the Upper Palaeozoic (Tiegs and Manton, 1958). Their juvenile stages could have been aquatic or semi-aquatic, living in non-saline swamp pools. From such forms emerged the modern insects, most of which are now completely terrestrial and independent of aqueous environments.

Special adaptations of insects to an aerial existence include the development of a hardened cuticle, often impregnated with lipids, which not only affords protection from physical damage but also retards loss of water; a breathing system of non-collapsible tracheae, whereby oxygen is distributed to the tissues by diffusion (this system is progressively less efficient as internal distances increase, resulting in an eventual limitation of body size); and wings, permitting migration to far distant or isolated areas that otherwise might have been inaccessible. The evolution of complete metamorphosis, which allows adults to exploit habitats totally different from those of the young, further extends their range of available habitats. Thus, two trends seem to pervade insect evolution: achieving independence from the damp habitat in which their ancestors evolved, and increasing their ability to disperse.

To return to an aquatic existence, insects, which are primarily terrestrial or aerial organisms, have to solve several ecological, physiological and physical problems. For such a return to be possible there must be 'bridging' habitats. Between land and sea such environments are provided by estuaries, saltmarshes, mangrove swamps and the intertidal zones. The majority of our so-called marine insects are still found in such habitats.

It has been suggested that the highly successful Crustacea, which had already diversified much earlier in the Cambrian, had become so well-established in fully marine environments that competition and predation may have been important factors in limiting the further invasion of marine habitats by insects (Usinger, 1957).

In order to live in the sea, insects also have to overcome physical constraints of buoyancy and surface tension and physiological problems of respiration and osmoregulation.

A reduction in body weight and an increase in surface–volume ratio, while advantageous for becoming airborne, may be a hindrance for insects which have to penetrate air–water interfaces. Wings, too, tend to be a nuisance for such small animals associated with water or air–water interfaces. Many marine insects have become wingless (e.g. sea-skaters, see Ch. 8) or have reduced wings (e.g. chironomids, see Ch. 14). Others have fully developed wings but are flightless or weak fliers (e.g. certain shore bugs, beach flies and beetles, see Chs 9, 18 and 19). Such adaptations perhaps help to prevent these insects from being readily blown away from their proper habitat.

Insects that become temporarily submerged need some means of breathing under water. Several marine species, notably the sea-skaters, are known to trap air between the hydrofuge hairs covering their bodies, and thus prevent drowning. Other special respiratory adaptations superimposed on the tracheal system include breathing siphons, blood-gills and various kinds of ‘physical gills’ (see Ch. 3). In one way or another all of these devices have been used by marine insects, but the mechanisms and structures have not been studied in as much detail as they have for a few of the freshwater species.

Experimental studies on the osmoregulation of marine insects have been carried out on larvae of the marine caddis-fly *Philaniscus plebeius* Walker (see Ch. 11), saltmarsh mosquitoes such as *Opifex fuscus* Hutton and *Aedes detritus* (Haliday) (see Ch. 2), and certain Corixidae (see Ch. 10). It is clear from these studies that some insects are able to osmoregulate over a wide range of salinities.

Perhaps the physiology of the muscular or nervous system of an insect is so specialized that it cannot tolerate physico-chemical conditions like those of sea-water. It may be that osmotic regulation and submarine respiration involve evolution of such different physiological adaptations that few insects have been successful in achieving both goals. This may be hard to prove, but what more plausible explanation could one suggest for the paucity of marine insects?

REFERENCES

Backlund, H.O. (1945) Wrack fauna of Sweden and Finland. Opusc. Entomol. suppl., 237 pp.

Buxton, P.A. (1926) The colonization of the sea by insects: with an account of the habits of *Pontomyia*, the only known submarine insect. Proc. Zool. Soc. Lond. 1926, 808–814.

Carpenter, G.H. (1901) The insects of the sea. Knowledge 24, 19–21, 51–54, 114–116, 161–163, 194–198, 245–248.

Edwards, F.W. (1926) On marine Chironomidae (Diptera): with descriptions of a new genus and four new species from Samoa. Proc. Zool. Soc. Lond., 1926, 779–806.

Mackerras, I.M. (1950) Marine insects. Proc. R. Soc. Queensl. 61, 19–29.

Marine Biological Association (1957) Plymouth Marine Fauna.

Pruthi, H.S. (1932) Colonization of the sea by insects. Nature 130, 312.

Smith, R.I. and Carlton, J.T. (Eds.) (1975) Intertidal Invertebrates of the Central California Coast.

Tiegs, O.W. and Manton, S.M. (1958) The evolution of the Arthropoda. Biol. Rev. 33, 255–337.

Thorpe, W.H. (1932) Colonization of the sea by insects. Nature 130, 629–630.

Tokunaga, M. (1932) Morphological and biological studies on a new marine chironomid fly, *Pontomyia pacifica*, from Japan. Mem. Coll. Agric., Kyoto Imp. Univ. 19, 1–56.

Usinger, R.L. (1957) Marine insects. Geol. Soc. Am. Mem. 67, (1) 1177–1182.

Walsh, G.B. (1925) The coast Coleoptera of the British Isles. Entomol. Mon. Mag. 61, 137–151.