were caught by the writer in hoop-nets near Digby Island at the entrance to Prince Rupert harbour and a few carapaces were found on the shore near the Digby Island dock.

Size (male): (1) 88 mm. (2) 16 mm. (3) 64 mm. (4) 84 mm. (5) 130 mm.

Family—Grapsidae.

Hemigrapsus nudus (Dana)—the "purple shore crab".

This species is found abundantly on rocky shores, a dozen or more frequently being found under a single rock. The carapace is almost square in shape and purplish in colour. The legs are without hair in contrast to H. oregonensis, a crab very similar in appearance and to be found in the same habitat. Great variations occur in markings and colour. Several egg-bearing females were observed in June, 1930.

Size (large male): (1) 36 mm. (2) 41 mm. (3) 62 mm. (4) 42 mm.

Hemigrapsus oregonensis (Dana)—the "yellow shore crab", "mud crab", or "hairy shore crab".

This species closely resembles H. nudus in shape and size but differs in lacking red spots in its chelae, in having hairs on its ambulatory legs and in being yellowish-grey in colour. As in the case of H. nudus, the distribution is very general. A few egg-bearing females were noted during June and July, 1930.

Size (small male): (1) 12 mm. (2) 14 mm. (3) 14 mm. (4) 15 mm.

INSECT PARASITES OF VERTEBRATES AND HOST PHYLOGENY

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IN RECENT years many students of various groups of parasites have come to realize that there is, apparently, a significant relationship between the specificity of obligate parasites and host phylogeny. So numerous are the examples which may be cited from various animal groups in illustration of this relationship that one is led to believe that there is involved a general, but nevertheless definite, biological principle. This might be briefly stated in this manner—that parasites provide a key to the genetic relationships of their hosts.

Various workers have pointed out that certain species of parasites, in the groups in which they were working, are possessed in common by groups of related host species. These workers have developed the idea, more or less independently, that conditions on, or in, the body of the host have remained practically unchanged over long periods of time while the host individuals themselves have been subjected to various and changing environmental conditions and geographical isolation. While body temperature, presumably blood composition, character of pelage and density of population on, or in, the host have remained relatively constant the host has been subjected to the changing environmental influences to which I have referred. Variations which might become implanted in the host and established through geographical isolation would presumably have no part to play in controlling the evolution of the parasite. The result has been that the evolutionary progress of the parasite has been slow while the host has given rise to new species and even to groups of generic and family significance. In other words the parasite which is common to several related host species is the form which was parasitic upon the common ancestor of these host species.

An interesting feature of a study of this problem is that a number of men arrived at the same general idea quite independently. The first person really to make reference to the question of host relationships and parasites was Vernon Kellogg working on the Mallophaga or biting lice of birds and mammals. In 1896 he lists a large number of species of Mallophaga common to both North American and European birds and says:—"The occurrence of a parasitic species common to European and American birds ... must have another explanation than any yet suggested. This explanation, I believe, is, for many instances, that the parasitic species has persisted unchanged from the common ancestor of the two or more now distinct but closely allied bird-species." Kellogg developed this idea in later papers both with respect to birds and mammals. Von Ihering had in 1892 made a passing reference to the occurrence of a parasite on its host in different geographic regions and in 1902 he made much use of host parasite data in a study of geographical distribution. Zschokke in 1898-99 made definite use of cestode parasites in attempting to establish the common origin of South American and Australian Marsupials. Harrison working on Mallophaga claimed to have arrived at the idea independently of Kellogg and in later papers he did much to apply the theory to various groups. Williams writing in 1909 on an epidemic among the New England Indians in
1916-20 showed that he realized the significance of parasitic diseases of man in relation to the origin and distribution of human races. Hadwen, working with the Oestridae, the bots and warbles, had been impressed with the question of parasites and host relationships as early as 1916, though his published papers do not refer to it. Darling in 1921 made independent use of the theory with respect to hook worm infestation of man. Metcalf, at about the same time, working on ciliate infusorian parasites of frogs discussed host relationships and distribution. Metcalf has elaborated this work in later papers and with Harrison has undoubtedly made the most complete survey of the field. We see then that at least eight men developed this theory quite independently of one another—each, at first, from evidence secured in the group in which he was working.

The theory, or method, if sound, and the writer believes it to be so, has wide application not only with respect to host phylogeny, but also with respect to questions of geographical distribution and paleogeography.

It is interesting to note that despite the fact that this principle is accepted by many parasitologists, and that quite an extensive literature is available on it, practically no reference is made to it in general text books of zoology or parasitology. An outstanding exception is Wenyon's *Protozoology*.

My interest in the problem of parasites and host relationships has come from my work on the Mallophaga or biting lice of birds and mammals. As I collected and studied material in this group I became more and more impressed with the idea, even though at the beginning I had of course only Kellogg's first reference to the question. Later papers of other workers and additional records of my own confirmed me in my belief. As I repeatedly found species from American hosts which were apparently identical with European material from related hosts I became convinced that the explanation could only be that the parasite species has come down unchanged from the common host ancestor.

I could cite here numerous examples of Mallophagan species common to American and European host species. I could not better illustrate the point in question, however, than by referring to a small collection of Mallophaga sent to me for examination by Professor Spencer of the University of British Columbia and reported upon by him before this Society. It must be borne in mind that this is a small collection taken at random and not selected particularly for my purpose. The material, taken in British Columbia, includes two species from the Raven, two from the Banded Pigeon, one from the Blue Heron and one from the Steller Jay. All of these but one were new host records and four were new American records. Let us note the host relationships in Europe of these Mallophaga taken on birds in Canada which are all American species. Both species from Raven have been recorded by European writers from various species of Corvus. One species from Banded Pigeon is recorded from various species of Columba in Europe and the other is the common Eudoxocorus colomba of domestic pigeons the world over. The species from Blue Heron is recorded from various species of Ardea in Europe. The species from Steller Jay, though I have not had an opportunity to examine the type, is apparently a form described from a Blue Magpie of Southern Europe and a member of the same family as the Steller Jay. Of the six species in the collection four are recorded from hosts of the same genera in Europe. One is found the world over on a domesticated species of the same genus as its British Columbia host and the sixth is recorded from a member of the same host family in Europe.

If we had no more evidence than that offered by this little group of Mallophagan species, collected at random, we should be forced to admit that it is at least strikingly suggestive. And we could produce numerous records of Canadian Mallophaga equally striking.

Many other workers in the group have made much use of Mallophaga with respect to avian and mammalian phylogeny. The relationship between Australian and South American Marsupials has been borne out by the relationship of the Mallophagan parasites. Harrison has determined that the biting lice of Apteryx form a definite group of a genus found otherwise only on Rails. He has suggested a primitive close relationship which had been previously suggested by Gadow on purely morphological grounds. We have numerous records where Mallophagan parasites occur on definitely related hosts. Accepting the suggested thesis then evidence such as that with respect to Apteryx and the rails may be of much value in determining doubtful phylogenetic relationships of hosts.

The suggestion may be advanced that the establishment of a species on two hosts not otherwise apparently closely related may be due to stragglers to and resultant establishment on the second host. It is a fact, however, that even where such stragglers must continually occur, establishment of the straggling parasite on its unnatural host is extremely rare. Owls and other birds of prey provide excellent opportunity for the establishment of parasites of their prey upon
themselves; yet I know of no record in the literature of the occurrence of a mammal louse upon such bird hosts and no record of the establishment of a species from a passerine bird. Cuckoos should provide an admirable illustration of straggling, if stragglers become established, because of the certain infection of the young in the nest. There is, however, no record of lice of foster parents on cuckoos—only records of true cuckoo-infesting species. And by the way, these latter are not constant in occurrence since the only possible transference of the species must take place at mating. With bird species in which parents incubate the eggs, transference, of course, takes place to the young in the nest.

There must be a reason why Mallophagan species seldom become established on unrelated hosts. To the writer it must be that the chemical constitution of blood, skin and plumage of the unnatural host is such that its body not only does not provide an attractive source of food and shelter, but may possibly provide actual lethal conditions for the straggling parasite.

Argument might be advanced that many cases might represent instances of parallel development. Relationships of the parasite species are too exact, however, and examples are far too numerous for such an explanation. All members of the genus Tetraphthalus are parasitic within the gular pouches of various species of pelicans. All exhibit this specialized form of parasitism and all have their body structure, especially the tracheal system, modified in relation to this mode of life.

The Anoplura or sucking lice provide numerous examples. Let us cite one. The members of the genus Pediculus of man have their nearest relative in species of the genus on anthropoid apes. The genus also occurs on the South American monkey Ateles, but the work of Friedenthal shows that on the basis of composition of the blood and hair this new world monkey shows certain differences from other tailed monkeys and certain relationships to the anthropoids. So that even if Ateles secured its Pediculus from man its establishment on the host might be presumed to be because of these very related peculiarities of its blood composition. On the other hand Ewing, after a comparison of Ateles lice with those of prehistoric North and South American mummies, concludes that if Ateles lice came from man they did so in very ancient times. The lice of other monkeys belong to a related but distinct genus Pediculosis. On the basis then of the louse fauna the blood relationship of man and the anthropoids is closer than that of the anthropoids and other monkeys save Ateles.

With regard to the Cestodes, the horse bots, ox warbles, etc., the specificity of the group in respect to host relationship is evident. At the American Association meeting in 1916 Hadwen made the statement that he was convinced from his work, that the bots were very ancient parasites. That evening Cockerell showed photographs of bot larvae from the Tertiary period in the Lower Eocene of which Eobipus had its origin.

In other groups of animal parasites work is being done to aid in determining host relationships and geographical distribution. The Protozoa, Cestodes and Trematodes provide numerous examples. It is interesting to note that in many cases the relationships of these forms from other groups support the evidence offered by insect parasites of the same hosts. For example, the lice of the ostrich and the American rhea are apparently closely related, being distinguished from all other Mallophaga by a peculiar asymmetry of the sclerotized border of the clypeus. A species of tapeworm occurs in both hosts. The Nematode genus Echinonema includes two species, one in an Australian Marsupial and one in a marsupial of South America. I have already referred to the relationship of the louse parasites of these forms. We spoke of the apparent blood relationship, or resemblance of the New World Ateles to man and anthropoids. In Sandground’s infection experiments with Strongylodes fahlihorni, a common parasite of Old World monkeys including anthropoids, he secured infection to the eighth day in man and to the sixth day in Ateles and not in any other forms.

I have dealt only with insect parasites of vertebrates. How far this suggested principle may be supported by evidence from insect groups parasitic upon insects and other invertebrates I do not know. I would suppose, however, that the evidence would be much more meagre than with respect to the former groups since many insect parasites of other insects are facultative rather than obligative in the specificity of their parasitism.