J. mar. biol. Ass. U.K. (1959) 38, 249–261
Printed in Great Britain

ECOLOGY OF THE GENUS *ACANTHOCHONDRIA* OAKLEY (COPEPODA PARASITICA)

By Z. Kabata

The Marine Laboratory, Aberdeen

(Text-figs. 1–4)

Among the parasites of the branchial chamber of the flatfishes of the Eastern North Atlantic, those belonging to the genus *Acanthochondria* (fam. Chondracanthidae, tribe Cyclopiformes) occupy a conspicuous place. Both their relatively large size and their abundance, render them easily noticeable even to a casual observer, in spite of the protective nature of their environment. It is a reflexion on the state of our knowledge of marine parasites that, notwithstanding their accessibility, very little is known about the animals of this genus.

The genus *Acanthochondria* was erected by Oakley (Leigh-Sharpe and Oakley, 1927) for the chondracanthids, which until then were included in *Chondracanthus* Delaroche, 1811, and which differed from the other members of that genus in the absence of the cephalic barbs and the dorsal and ventral processes. They were also characteristic in their preference for the flatfish hosts.

The workers who studied the family Chondracanthidae in the past were chiefly concerned with its taxonomy. A short résumé of the work on the family was given by Oakley (1930), who contributed greatly to our understanding of the relationships of the chondracanthids, but did not go beyond their systematics. Of the more recent workers Heegaard (1945, 1947) studied the development of *Acanthochondria*, and Deboutteville (1951 *a, b*) the general biology of the chondracanthids by observation, among others, of living animals. Their work, however, was also intended to bring out the taxonomic and phylogenetic relationships, both within the family and within the Arthropoda as a phylum. Similar purposes were served by the work of Illg (1948).

It is intended in this paper to consider the genus *Acanthochondria* from the ecological point of view, by discussing the distribution, abundance and the details of the habitats of its members in the Eastern North Atlantic. The latter term is used here to cover three areas: the northern North Sea and the seas around the Faroe Islands and Iceland. The great majority of data obtained in the course of this work were collected by the Fishery Research Ships "Scotia" and "Explorer" of the Scottish Home Department's Marine Laboratory, Aberdeen. Some of the specimens of *A. cornuta* were collected by the Laboratory's earlier vessel "Goldseeker" in Scottish waters in 1921 and those of *A. solae* came from the collection of the late Dr T. Scott, now in the Royal Scottish Museum, Edinburgh.

ACANTHOCHONDRIAN FAUNA OF THE AREA

It is unfortunate that no agreement seems to exist at present as to the number and identity of the species of *Acanthochondria* occurring in the area under investigation. Apart from three undoubtedly valid species (*A. clavata*, *A. limandae* and *A. depressa*) there exist three more (*A. cornuta*, *A. flurae* and *A. solae*), the identity of which has been doubted by some authorities. Brian (1906) suggested that *A. flurae* and *A. solae* are merely varieties of *A. cornuta*. Hansen (1923) also regarded *A. cornuta* and *A. flurae* as being phenotypes of the same species. Hansen's opinion was accepted by Stephensen (1940) but not followed by Leigh-Sharpe & Oakley (1927), Oakley (1930) and Oorde-de Lint & Stekhoven (1936).

A. solae has not been found by the author. It is very rare in the area and will not be considered in detail in this paper. The morphology of the specimens from Dr T. Scott's collection was so distinct, that the author found it impossible to agree with Brian's opinion concerning this species. Brian's and Hansen's objections to the separation of *A. flurae* from *A. cornuta* cannot, however, be easily dismissed. Those who believe these two parasites to be distinct, regard the shape of the trunk as the main discriminant. The trunk of *A. cornuta* is taken to be long and slender, that of *A. flurae* short and squat. Another distinguishing feature used is that of specificity, *A. cornuta*, apparently occurring on the plaice, *Pleuronectes platessa* L., while *A. flurae* occurs on the long rough dab, *Drepanopsetta platessoides* Malm. According to Hansen, however, all the intermediate stages between the two typical shapes of the trunk existed and could be found on both flatfishes.

To check quantitatively the range of variation in the shape of the trunk of both parasites, the author compared the length: width ratios of 106 specimens collected from the long rough dab with those of 31 specimens from the plaice. The ratios of the former ranged from 1·9 to 3·3 (mean ratio 2·5) and those of the latter from 2·8 to 5·0 (mean ratio 3·6). Statistical analysis shows the significance of the difference between these groups of ratios to be at 0·001 level. It would appear, therefore, that in spite of some overlap of ratios the retention of the specific status for both these parasites is correct. The position is made complicated, however, by the existence of a population of *Acanthochondria*, superficially resembling those on the plaice (*cornuta* type), on the witch, *Glyptocephalus cynoglossus* (L). This flatfish has been previously recorded as a host of *A. flurae*. The examination of 10 specimens from it has shown their length: width ratios to range between 3·8 and 6·0 (mean ratio 4·8). The level of significance of the difference between the parasites of the plaice and those of the witch is also at 0·001 level. We have thus three significantly different populations, one (from the long rough dab) of *flurae* type and two of *cornuta* type.

The mouthparts of *Acanthochondria* have been studied by Oakley (1930) and were used by him as diagnostic features in identifying various species of the genus. His valuable work is now in some respects outdated and the mouthparts require re-examination. Because of the scarcity of material, Oakley (personal communication) was unable to dissect his specimens and had to rely on the examination of whole mounts. Examined from one aspect only, the shape of the mandibular palp,* as shown by Oakley, bears only a general resemblance to this appendage as examined by the author. In our present state of knowledge this structure cannot be used in diagnosing specific differences.

TABLE 1. SPECIES OF *ACANTHOCHONDRIA* OCCURRING IN THE EASTERN NORTH ATLANTIC AND THEIR HOSTS

	Host species	
Species of *Acanthochondria*	According to previous reports	As found by the author
A. cornuta (O. F. Müller, 1777) (Fig. 1)	*Platichthys flesus* (L.), *Pleuronectes platessa* L., *Scophthalmus maximus* (L.), *Lepidorhombus whiff-iagonis* (Walbaum)	*Pleuronectes platessa* L., *Glyptocephalus cynoglossus* (L.)
A. solae (Krøyer, 1838)	*Solea vulgaris* Day, *Platichthys flesus* (L.), *Pleuronectes platessa* L.	
A. flurae (Krøyer, 1863) (Fig. 1)	*Drepanopsetta platessoides* Gill, *Glyptocephalus cynoglossus* (L.)	*Drepanopsetta platessoides* Gill, *Lepidorhombus whiffiagonis* (Walbaum), *Platichthys flesus* (L.)
A. limandae (Krøyer, 1863) (Fig. 1)	*Limanda limanda* (L.) *Platichthys flesus* (L.)	*Limanda limanda* (L.)
A. clavata (Basset-Smith, 1896) (Fig. 1)	*Microstomus kitt* (Walbaum)	*Microstomus kitt* (Walbaum)
A. depressa (T. Scott, 1905)	*Platichthys flesus* (L.)	

No final decision can as yet be reached on morphological grounds as to the distinctness of the two species. Ecological differences, however, encountered by the author in his study of *Acanthochondria*, tended to separate the parasites of the long rough dab on the one hand and those of the plaice and the witch on the other. In view of those differences the author decided to treat them as distinct and regard those from the long rough dab as *A. flurae* and those from other two hosts as *A. cornuta*.

Bearing the foregoing remarks in mind we can now postulate that six species of *Acanthochondria* occur in the investigated area. They are listed in Table 1, which shows also their host species, both as they are recorded in literature and as found by the author.

---

* Regarded by Heegaard (1947) as the first maxilla.

Numerous records of the occurrence of *Acanthochondria* in the eastern North Atlantic have been quoted by Oorde de Lint & Stekhoven (1936). According to these records, *A. cornuta* (Fig. 1 A) occurs in various parts of the North Sea and at Faroe and Iceland. *A. clavata* (Fig. 1 D) is said to occur in the North Sea (Firth of Forth), Firth of Clyde, and at Faroe. *A. depressa* occurs in the North Sea, *A. flurae* (Fig. 1 B) on the Scottish coast and at Faroe and Iceland, *A. limandae* (Fig. 1 C) in Moray Firth and Firth of Clyde and at Faroes, *A. solae* in the North Sea.

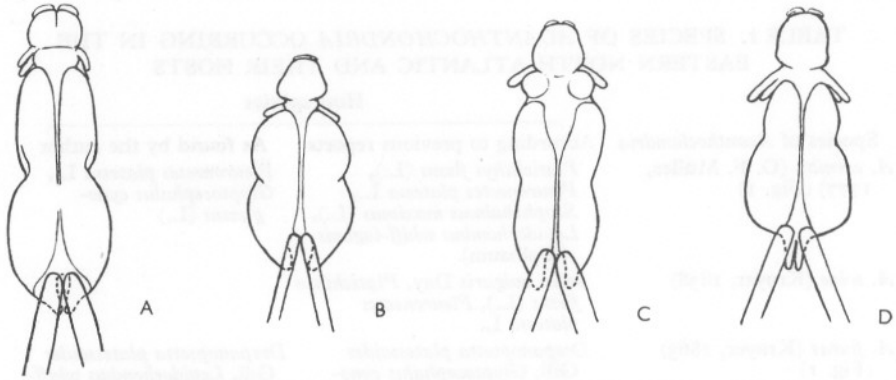

Fig. 1. General appearance of (A), *Acanthochondria cornuta*, (B) *A. flurae*, (C) *A. limandae* and (D) *A. clavata*.

To study the incidence of *Acanthochondria* the author examined 3961 flatfishes: 2553 from the North Sea, 419 from Faroe and 990 from Iceland. No specimens were found of *A. solae* or *A. depressa*. The latter species infests the flounder, *Platichthys flesus* (L.), and this fish was not extensively examined by the author, as the majority of the samples were collected from the open sea. The remaining four species, according to the data collected, are distributed quite widely throughout the localities inhabited by the host populations and show no distinct pattern of distribution within the separate areas.

The genus *Acanthochondria* shows a decrease in the number of species in the northerly direction. Six species are present in the North Sea, four off the Faroes and only two off Iceland. *A. depressa* and *A. solae* are absent from the acanthochondrian fauna of Faroes and Iceland. Only *A. flurae* and *A. cornuta* have been found in Icelandic waters. The explanation of this pattern in terms of limits to the distribution of the host populations is not quite satisfactory. For example, the lemon sole, *Microstomus kitt* (Walbaum), is found throughout the entire area, but is not infested at Iceland.

Consideration of distribution of *Acanthochondria* invites speculation on the way in which this genus spread throughout the area. The spread seems to have proceeded northwards from a southern centre, probably the environmental conditions acting as the chief limiting factors. A similar way of colonizing the northern grounds has been suggested by the author (1957) for the genus *Lernaeocera*.

ABUNDANCE

The abundance of *Acanthochondria* varies quite considerably both from species to species and from area to area.

In the North Sea *A. flurae* and *A. clavata* infest more than 20% of their host populations, *A. cornuta* 11% and *A. limandae* 2% (Table 2). A similar relative abundance is shown by the two species present at Iceland, *A. flurae* and *A. cornuta* (Table 3).

TABLE 2. ABUNDANCE OF *ACANTHOCHONDRIA* IN THE NORTHERN NORTH SEA

Flatfish species	No. examined	No. infested	% infested	Species of parasite
Pleuronectes platessa	155	8	5·2	*A. cornuta*
Platichthys flesus	19	2	10·5	*A. flurae*
Microstomus kitt	407	96	23·6	*A. clavata*
Drepanopsetta platessoides	1001	202	20·2	*A. flurae*
Limanda limanda	704	17	2·4	*A. limandae*
Glyptocephalus cynoglossus	98	11	11·2	*A. cornuta*
Lepidorhombus whiff-iagonis	159	—	—	—
Hippoglossus hippoglossus	9	—	—	—

TABLE 3. ABUNDANCE OF *ACANTHOCHONDRIA* OFF ICELAND

Flatfish species	No. examined	No. infested	% infested	Species of parasite
Pleuronectes platessa	118	9	7·6	*A. cornuta*
Microstomus kitt	131	—	—	—
Drepanopsetta platessoides	410	96	23·2	*A. flurae*
Limanda limanda	105	—	—	—
Glyptocephalus cynoglossus	101	3	2·9	*A. cornuta*
Lepidorhombus whiff-iagonis	96	1	1·0	*A. flurae*
Hippoglossus hippoglossus	29	—	—	—

TABLE 4. ABUNDANCE OF *ACANTHOCHONDRIA* OFF THE FAROES

Flatfish species	No. examined	No. infested	% infested	Species of parasite
Pleuronectes platessa	26	10	38·5	*A. cornuta*
Microstomus kitt	150	59	39·3	*A. clavata*
Drepanopsetta platessoides	62	11	17·7	*A. flurae*
Limanda limanda	70	25	35·7	*A. limandae*
Hippoglossus hippoglossus	111	—	—	—

The abundance of acanthochondrians off the Faroes is, however, quite different (Table 4). With the important exception of *A. flurae*, which shows an infestation incidence of the same order as in the other areas, all the three remaining species are much more abundant. Most surprising is the increase in abundance in comparison with the North Sea of *A. limandae* and *A. cornuta*, both of which infest over 30% of their host populations.

The abundance of a parasite cannot be fully measured by the percentage of the host population infested. It is also important to consider the numbers of parasites on an individual host. The details of this aspect of abundance are shown in Table 5.

TABLE 5. NUMBERS OF *ACANTHOCHONDRIA* ON AN INDIVIDUAL FISH

	North Sea		Faroes		Iceland	
Species	Nos. on one fish	$\frac{\text{Host}}{\text{Parasite}}$	Nos. on one fish	$\frac{\text{Host}}{\text{Parasite}}$	Nos. on one fish	$\frac{\text{Host}}{\text{Parasite}}$
A. flurae	1–5	3·5	1–3	4·1	1–7	2·7
A. cornuta (witch)	1–5	5·3	—	—	1–2	25·2
A. cornuta (plaice)	1–2	16·6	1–6	1·3	1	10·7
A. clavata	1–9	2·3	1–23	0·98	—	—
A. limandae	1–2	26·1	1–2	2·0	—	—

HABITAT

The members of the genus *Acanthochondria* are described by various authors as parasites of the gill cavity, of the gill arches or the gills. No study has been made, to the knowledge of the author, to determine the exact character of their habitat. Even less is known of the possible differences of the habitat between the species.

The numbers of both parasites and hosts studied in the course of this work have been sufficiently large to learn something of the habitats of *Acanthochondria*. No two species of this genus were identical in the manner of distribution within the gill cavity of their corresponding hosts. There existed also differences in the manner of association of *A. cornuta* with its two different hosts.

To examine habitats available to *Acanthochondria* on potential hosts, the opercular cavities of seven flatfish species were examined, by dissection and by making casts of subopercular spaces in latex rubber. The latter method is especially useful, as the shape of the cast remains unaffected by any strains during its removal.

The study of the respiratory apparatus of flatfishes has shown differences between the species, which may be said to form a range between two extremes, referred to here as "open" and "closed" types. The difference between the two types depends on the degree of development of the branchiostegal membranes, their relationship in space to the gills, on the amount of free space under the opercula and on the size and the shape of the mouth gape. The most typical representatives of the "open" type are the halibut, *Hippoglossus hippoglossus* (L.) and the megrim, *Lepidorhombus whiff-iagonis*. It will be seen from Fig. 2A that the branchiostegal membrane of the megrim is narrow, forming only a shallow pocket with the operculum, along the posterior border of which it is missing altogether. With the operculum *in situ* the inner rim of the membrane is situated at some distance from the tips of the gill filaments, especially in the posterior part of the cavity. The gills, in other words, are not enclosed in the branchiostegal pocket. The membranes of the opposite opercula are not fused to any great extent. The gape of the mouth is wide. It appears that this type of the respiratory apparatus is associated with active mode of life, since the halibut shows an essentially similar type of the gill cavity. These two fishes are not infested by *Acanthochondria* (149 of the examined halibut were found to be free of infestation and on 254 megrims only one specimen of *A. flurae* was found attached to the gill raker, a quite atypical habitat).

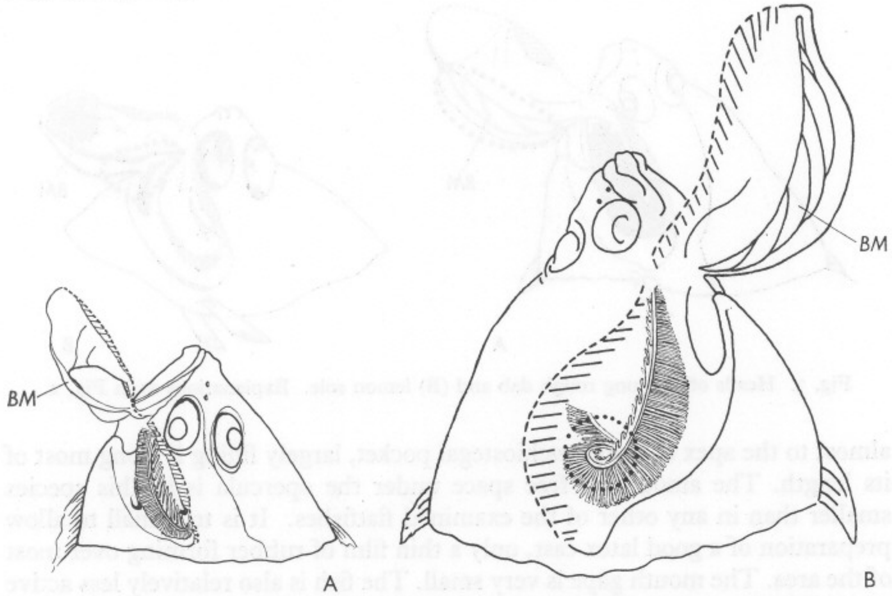

Fig. 2. Heads of (A) megrim and (B) plaice, with operculum dissected away to show spatial relations between various elements of the respiratory mechanism. Area of attachment of parasites indicated by dotted ring. *BM*, branchiostegal membrane.

Three further species of flatfish: the plaice, *Pleuronectes platessa* (Fig. 2B), the common dab, *Limanda limanda*, and the long rough dab, *Drepanopsetta platessoides* (Fig. 3A) are also of the 'open' type, although more towards the other end of the range. Their branchiostegal membranes are better developed, the tips of the gill filaments being just within the branchiostegal pockets. The gapes of the mouths are smaller than in the two preceding species, but still relatively well developed. These fishes, as far as we know, differ among themselves to some extent in their modes of life, the long rough dab being predatory and most active of the three. Not enough is known about the differences between the other two species, but their inclusion into the same group is not contrary to anything we know about their lives.

Nearer still towards the 'closed' type is the witch, *Glyptocephalus cynoglossus*, in which the branchiostegal pocket is more strongly developed, the membranes enclosing more of the gills and fusing with each other for a longer distance than in the preceding species. The gape of the mouth is smaller also.

At the end of the range is the extreme example of the 'closed' type, the lemon sole *Microstomus kitt* (Fig. 3B). In this species the membranes are fused quite a long way, enclosing the urohyal element of the pectoral girdle. The membranes are well developed, although narrowing posteriorly, and extend right round the opercular opening. The tips of the gill filaments project almost to the apex of the branchiostegal pocket, largely filling it along most of its length. The amount of free space under the opercula is in this species smaller than in any other of the examined flatfishes. It is too small to allow preparation of a good latex cast, only a thin film of rubber forming over most of the area. The mouth gape is very small. The fish is also relatively less active than other flatfishes, as indicated by its diet.

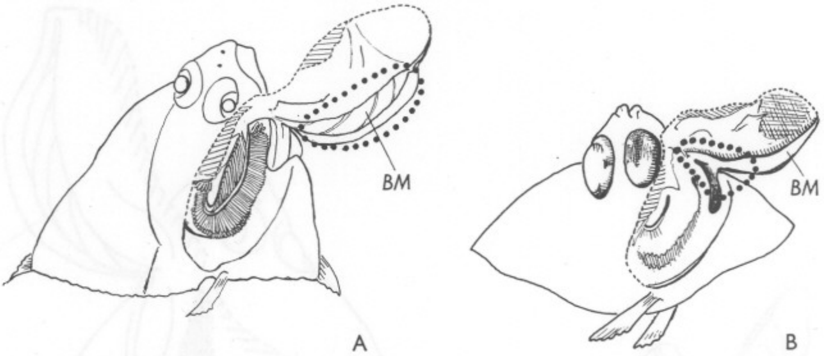

Fig. 3. Heads of (A) long rough dab and (B) lemon sole. Explanations as in Fig. 2.

As mentioned before, the first two species of the 'open' type are not infested by *Acanthochondria*. The next group of three shows two different ways of association with it. The first kind is illustrated by the distribution of *A. flurae* on the long rough dab (Fig. 4A). For the purpose of recording the distribution of the parasites within the opercular cavity, it was divided into four sections: three of roughly equal length along the edge of the operculum, the fourth comprising the urohyal. (The double line in the diagram indicates the extent of fusion of the branchiostegal membranes.) It will be seen that the great majority of the parasites (a sample of 331 *A. flurae*) are attached to the two posterior sectors of the opercula, all being within the branchiostegal pocket. Relatively few are found in the anterior sector of the opercula, where the membranes are fused. About one-third of the total number are attached to the urohyal. There is no significant difference between the two sides of the gill cavity, the ocular side harbouring 44·4 % and the blind side 55·6 % of the parasites.

The distribution of the parasites on the other two members of this 'open' group is entirely different. *A. cornuta* on the plaice is found in a very definitely circumscribed and small locality (Fig. 2B). It is attached usually in the narrow space between the end of the first branchial arch and the pseudobranch. Only very few exceptions were found in the anterior end of the opercular cavity, all firmly wedged between the bases of the branchial arches. *A. limandae* on the common dab is found only in the latter place. No parasites were found in the branchiostegal pocket of either plaice or common dab.

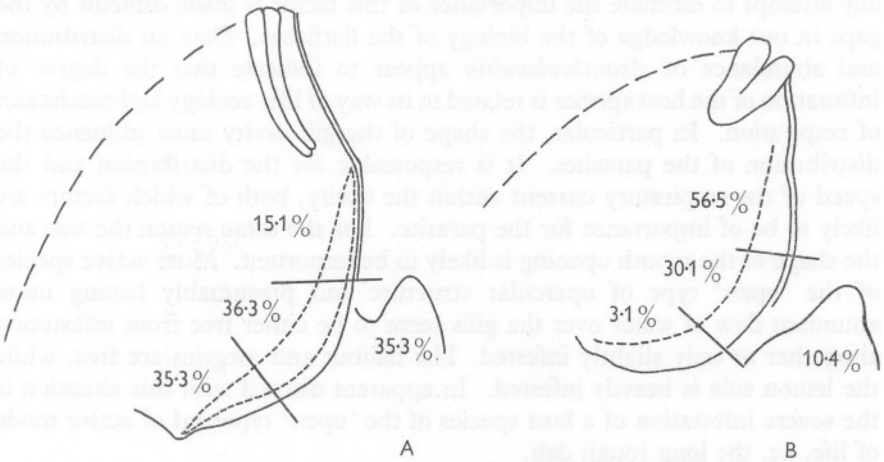

Fig. 4. Diagrams of the heads of (A) long rough dab and (B) lemon sole, showing the distribution of *Acanthochondria* in the opercular cavity.

The witch, more closely resembling the 'closed' type of the opercular structure is also infested with *A. cornuta*, which is so strikingly limited in the distribution on the plaice. Only few parasites were found on the witch, but those found were distributed along the branchiostegal pocket, not showing special preference towards any particular sector. None were present in the cleft between the pseudobranch and the base of the first gill arch and none either between the anterior bases of the arches.

The last of the hosts, the typically 'closed' type lemon sole, is heavily infested with *A. clavata*. The distribution of this species on the lemon sole is indicated by the dotted ring in Fig. 3B and diagram in Fig. 4B. The latter figure shows that more than a half of the sample of 193 parasites were distributed in the anterior sector of the branchiostegal pocket. The numbers of parasites in that pocket decreased posteriorly, only few being found in the posterior sector, where the membranes are most narrow. In this species there is also no appreciable difference between the ocular and the blind side of the cavity, the former carrying 52·3 % and the latter 47 % of the parasites.

DISCUSSION

The form of the host-parasite relationship is the outcome of the interaction of three factors: the host, the parasite and the external environment. All three factors contribute influences responsible for the final equilibrium. In the association between *Acanthochondria* and its flatfish hosts the operation of all these influences seems to be indicated by the facts related in the preceding sections of this paper.

The ecology of the host is undoubtedly responsible for the development of the specific relationship between it and the parasitic species. Unfortunately, any attempt to estimate the importance of this factor is made difficult by the gaps in our knowledge of the biology of the flatfishes. Data on distribution and abundance of *Acanthochondria* appear to indicate that the degree of infestation of the host species is related to its way of life, ecology and mechanics of respiration. In particular, the shape of the gill cavity must influence the distribution of the parasites. It is responsible for the distribution and the speed of the respiratory current within the cavity, both of which factors are likely to be of importance for the parasite. For the same reason the size and the shape of the mouth opening is likely to be important. More active species of the 'open' type of opercular structure and presumably having more abundant flow of water over the gills seem to be either free from infestation altogether or only slightly infested. The halibut and megrim are free, while the lemon sole is heavily infested. In apparent discord with this situation is the severe infestation of a host species of the 'open' type and of active mode of life, i.e. the long rough dab.

It is useful at this point to consider the role of the parasite in establishing host-parasite equilibrium. It seems that, on the whole, *Acanthochondria* favour habitats which are well protected and rather limited in the amount of free space. *A. cornuta* on the plaice appears to ignore the expansive areas of possible foothold offered by the broad branchiostegal membranes and lives only in the narrow gap, probably out of the way of the main respiratory current. The same species on the witch is found in the branchiostegal pocket, which in this fish is much narrower and has less free space, being filled by the tips of the gill filaments. It might be expected that the branchiostegal pocket of the witch has less flow of water and affords more protection than that of the plaice. *A. limandae*, found on the common dab, a fish of the same type as plaice, is also attached in a well protected and narrow space, this time between the bases of the gill arches. *A. clavata*, so abundant on the lemon sole, also appears to be most common in the best protected part of the branchiostegal pocket. Apart from the sensitivity to the conditions of the current, this might be related in some way to the well-developed tactile sense of the chondracanthids (Stekhoven, 1934; Goggio, 1927). It is not unlikely that a habitat affording optimal thigmotropic conditions might be chosen by a parasite which appears to possess some power to change the place of attachment (Stekhoven, 1934).

Structural similarity of various species of *Acanthochondria* is not necessarily paralleled by biological uniformity. It is probable that they differ among themselves both in demands put on their hosts and in the range of tolerance of the conditions of the external environment. One fact, pointing to possible biological differences is, for example, the difference in fecundity. According to the production of eggs per individual, the four species investigated in this paper can be divided into two groups:

	No. of eggs	Diameter of eggs (mm)
A. flurae	1,427	0·15
A. clavata	1,328	0·15
A. limandae	860	0·13
A. cornuta	759	0·14

The individuals sampled for egg counts were chosen so as to avoid possible variations due to the size of the animal, the locality and the season of the year. Statistical analysis of these numbers shows the difference between the two groups to be significant at the 0·001 level. The two less fecund species are also less abundant in two out of three areas examined. Both are also restricted to a very small locality in distribution on their hosts. Their eggs are slightly smaller, perhaps due to the lesser quantity of yolk contained and this might be of biological significance. It is also interesting that the only available specimen of the very rare *A. solae* had only 328 eggs, 0·12 mm in diameter, both values being lowest for any individual of any species examined.

Summing up the above considerations we might say that: (i) the more active the flatfish species, the less it is used as a host by *Acanthochondria*; (ii) this may be due to the parasites of the genus preferring environments well protected and restricted in space; (iii) the species which are less fecund, and more restricted in distribution on the host, tend to be less abundant. There are two important exceptions to these general principles. One active host of the 'open' type, the long rough dab, is heavily infested, the incidence of infestation being of the same order in all areas (Tables 2, 3, 4). At the same time the distribution of *A. flurae* on the long rough dab is consistent with the distribution of the space available within the gill cavity, irrespective of the degree of protection. It is suggested that this is possibly due to the lesser need of protection and wider range of tolerance of the environmental conditions on the part of *A. flurae*. Such tolerance would tend to eliminate to some extent the environmental influences from the interplay of the three factors involved in the host-parasite equilibrium, leaving it undisturbed over the large area. Some differences in the environmental conditions undoubtedly exist between the North Sea, Faroe and Iceland. The absence of *A. clavata* from Icelandic waters inhabited by an abundant population of the lemon sole, indicates the possibility of environmental limiting factors. In face of such possible differences *A. flurae* maintains a fairly constant degree of abundance in all areas.

In contrast to this uniformity of abundance of *A. flurae*, two other species, *A. limandae* and *A. cornuta*, are highly abundant on their respective hosts, the common dab and the plaice, at the Faroes (Table 3) but not at Iceland or in the North Sea, where they are less abundant than *A. flurae* and *A. clavata* (Tables 2 and 4). It is suggested that this might be due to their greater susceptibility to the environmental conditions, which favour their abundance at the Faroes but oppose it in the North Sea and at Iceland. That the environment at the Faroes is particularly favourable to *Acanthochondria* seems to be indicated by the fact that all the species of this genus, with the exception of *A. flurae*, are more abundant in that area than elsewhere.

All the biological differences between *A. flurae* and the remaining species, including *A. cornuta*, seem to lend support to those who believe in the distinctness of *A. flurae* from *A. cornuta*.

The author wishes to express his gratitude to Dr J. H. Fraser of the Marine Laboratory, Aberdeen, for his criticism of the manuscript and suggestions for its improvement.

SUMMARY

Four species of *Acanthochondria* are discussed in relation to their hosts, the flatfishes. The more active flatfishes, with less protected opercular cavities, appear to be less suitable as hosts for this genus of parasites.

A. flurae (found on the long rough dab) is equally abundant in the North Sea and at Faroe and Iceland. *A. clavata* (found on the lemon sole) is abundant in the North Sea, even more so at Faroe, but is absent from Icelandic waters. *A. limandae* (found on the common dab) is scarce in the North Sea, abundant at Faroe and absent from Iceland. *A. cornuta* (found on the plaice and the witch) is scarce in the North Sea and at Iceland, but very abundant at Faroe.

The four species differ in distribution on their respective hosts, all with the exception of *A. flurae* choosing well protected environments, which vary with the host. *A. flurae* appears to be less sensitive to the environment and directed in its choice more by the amount of space available for attachment. The abundance of the parasitic species in the area depends probably also on the environmental conditions.

The difference in biology between *A. flurae* and other species supports the opinion that it is a separate species.

REFERENCES

BRIAN, A., 1906. *Copepodi parassiti dei peschi d'Italia.* 187 pp. Genova.

DEBOUTTEVILLE, C. D., 1951*a*. Présence de la sous-familie des *Pharonidae* Illg (Copepodes, *Chondracanthidae*) en Méditerranée et remarques sur la classification et la biologie des Chondracanthidae. *Arch. Zool. exp. gén.*, T. 87, pp. 139–55.

—— 1951*b*. Sur la biologie des Chondracanthidae (Crustacés Copépodes). *C.R. Acad. Sci., Paris*, T. 232, pp. 117–9.

GOGGIO, E., 1927. Richerche sulla vita, sulla conformazione esteriore e sulla struttura del *Chondracanthus lophii* Johnst. *Pubb. Staz. zool. Napoli*, Vol. 8, pp. 427–74.

HANSEN, H. J., 1923. Crustacea Copepoda. II. Copepoda parasita and hemiparasita. *Dan. Ingolf-Exped.*, Vol. 3, (7), 92 pp.

HEEGAARD, P., 1945. Remarks on the phylogeny of the arthropods. *Ark. Zool.*, Vol. 37. No. 3, 15 pp.

—— 1947. Contribution to the phylogeny of the arthropods. Copepoda. *Spolia zool. Mus. Hauniensis*, Vol. 8, 236 pp.

ILLG, P. L., 1948. *Pharodine*, a new subfamily of *Chondracanthidae* (Crustacea-Copepoda) and a description of *Pharodes biarensis* n.sp. from New Guinea. *J. Wash. Acad. Sci.*, Vol. 38, pp. 404–12.

KABATA, Z., 1957. *Lernaeocera obtusa* n.sp., a hitherto undescribed parasite of the haddock (*Gadus aeglefinus* L.). *J. mar. biol. Ass. U.K.*, Vol. 36, pp. 569–92.

LEIGH-SHARPE, W. H. & OAKLEY, C. L., 1927. *Lernentominae*, a new subfamily of *Chondracanthidae*, with a description of *Orialen triglae* (Blainville, 1822). *Parasitology*, Vol. 19, pp. 455–67.

OAKLEY, C. L., 1930. The Chondracanthidae (Crustacea: Copepoda); with a description of five new genera and one new species. *Parasitology*, Vol. 22, pp. 182–201.

OORDE DE LINT, G. M. VAN & STEKHOVEN, J. H. S., 1936. Copepoda parasitica. *Tierw. N.- u. Ostsee*, Teil 10C, pp. 13–198 (Lief 31).

STEKHOVEN, J. H. S., 1934. Zur Sinnesphysiologie der parasitären Copepoden *Lepeophtheirus pectoralis* (O. F. Müller) und *Acanthochondria depressa* (T. Scott). *Z. Parasitenk.*, Bd. 7, pp. 336–62.

STEPHENSEN, K., 1940. Parasitic and semiparasitic Copepoda. *Zoology of Iceland*, Vol. 3, Pt. 34, 24 pp.