

# THE EXCISTENCE OF AN AESTUARINE FISHFAUNA IN SOUTH EAST ASIA

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Before the outbreak of the war with Japan the author had the intention to publish an extensive account on the occurrence of an estuarine fishfauna in and in front of the large estuaries and river-mouths so often found in India, Burma, Malaya, Thailand and Indo China and in the Greater Sunda Islands, Sumatra and Borneo, the rivers of the latter two islands being the special field of investigation.

However as a consequence of the war all, thus far, unpublished notes and the greater part of the collections were lost as is the case with a most interesting sample of an estuarine fishfauna from South New Guinea, where biologically the same conditions exist as in Sumatran and Bornean river-mouths. This last collection remained partly unpacked when war broke out and its still unsorted part disappeared. Only about 20 % of the total was found back in a more or less good condition.

The present paper is more or less a summary therefore, written partly entirely by memory and partly it is based on already published papers; Cf. *Treubia* XIII, 1931, XIV, 1934, XV, 1936 and XVI, 1936.

The watermasses within and in front of the estuaries are of mixed origin from sea and river, subject to tidal streams often of considerable strength and its extent is variable as a consequence of the greater or lesser discharge of fresh water by the rivermouths in the wet and in the dry monsoon. This stretch of mixed water, the salinity of which ranges from that of pure seawater to totally fresh, can be recognised up to about 40 nautical miles in sea in the wet monsoon and sometimes only as less as 10 in the dry.

Going landwards from sea these estuarine waters can be easily detected at sight by the greener colour and a lesser transparency due to the greater amount of plancton, which in its turn is the consequence of a greater amount of phosphates and nitrates, which in some in extreme cases is even twice as much as in the open sea. The total amount of the phosphates however is

almost never exceeding 10 mg pro m<sup>3</sup>, much lower figures therefore than for instance in the North Sea and the Channel. For exact data I refer to DELSMAN, Plancton investigations in the Java Sea, Treubia XVII 1939.

Is thus the influence of the riverwater distinguishable far in sea, on the other hand water with some salinity is creeping up the river. Traces can be detected often far inland, depending on the strength of the freshwatercurrent of the river proper and much farther in an estuary where the stretch can be expressed in tens of nautical miles than in a deltariver with its stronger flow where saltwater sometimes does not come in farther than a few miles<sup>1)</sup>.

All or at any rate most of the rivers come from extensive peat morasts. This water contains relatively little silt, it is teabrown or even blackish in colour and has a low PH probably due to "humic acids". In extreme cases it is even as low as 4 or 5, whereas the calcium-, iron-, and silicate content is often relatively high. Anyhow the result of the mixing of this riverwater with the seawater in front of the rivermouth produces an area of high productivity, which expresses itself in a rich plancton content of vegetable and animal origin. A rich fauna of *Noctiluca* is found and of the bigger planctonic animals *Sergestes* may be mentioned in the first place.

The bottom in this area consists not of sand but of a very soft mud in contrast with the mud of a much harder consistence found in the open sea. Many burrowing animals are living here as for instance Polychaets, of which a species of *Aphrodite* present itself at once to the casual observer.

The amount of bottomfeeding crustaceans can be enormous and the different species or shrimps (*Penaeopsis* and *Parapenaeopsis*) form an important part of the fisheries in these regions. A small swimming crab *Charybdeella rostrata* (Millne Edwards) is common, Stomatopods are fairly abundant. Sea snakes are fairly abundant. Sea snakes are often seen, as is the case with different kinds of shore- and seabirds.

However from an economical as well as from a faunistical and biological standpoint the group of fishes is of the greatest importance. These waters are teeming with fishlife as can be judged from the amount of planctonic eggs as well as from the large fisheries developed in these regions.

This rich fishfauna is — for a tropical region — rather poor in species. In the best investigated area, the estuary of the Rokan, I counted only about 175 species, all occasional guests included. The number of common species forming the bulk of the commercial catches is much lower, often less than a half. Conditions found in the Rokan-mouth are essentially the same everywhere else. Differences found in relative abundancy of certain species are only of minor importance. The difference in the amount of silt carried of by a river seems however to be a factor of some biological importance, whether

1) For a detailed analysis see HARDENBERG, Treubia XVI, 1936.

directly or indirectly by providing better conditions of life for the plankton through a higher amount of nutrient salts I can not say now.

This estuarial fishfauna can be divided in several groups which of course cannot be confined sharply in all cases.

These biological constituents are:

- A. The real estuarine fishes;
- B. The coastal fishes;
- C. A group of species which live in fresh water and which are descending into the brackish;
- D. A group of species ascending into the fresh water out of sea;
- E. Occasional guests.

#### A. REAL AESTUARINE FISHES

Within the group of the true estuarine fishes I include only those species which pass their whole lifecycle in the estuaries themselves or in the planktonic belt of rich planktonic life in front of it. These species are therefore never or at any rate seldom found elsewhere. They are restricted to the mixing area of sea and riverwater.

Within this area smaller biological units can be distinguished depending on local circumstances as higher or lower salinity, strength of tidal stream, quality of mud and other factors. As these factors are of course not always the same for each river, differences in the constituents of the fauna can be expected and are as a fact found. In almost all cases however these differences are expressed only in relative abundance of the species. Seldom a species is or seems to be totally lacking as for instance is the case with *Thryssa kammalensis* (Blkr.), which seems to be absent in these areas in front of the South Borneo rivers. However one has to be careful with conclusions in this respect as methods of fishing are not the same everywhere.

Considering the most important species one is struck by the great abundance of Clupeids, especially the more primitive forms. Regularly for instance *Chirocentrus hypselosoma* Blkr. is found here, which is replaced in more coastal waters by its near relative *Chirocentrus dorab* Forsk.

Even more important is the genus *Setipinna*, of which especially *Setipinna taty* (C.V.) is a key species for the estuarine fauna, *Setipinna breviceps* (Cantor) is also found though in lesser numbers and occurs in water of a much lower salinity than *S. taty*. In fact it spawns as has been proven by DELSMAN<sup>2)</sup> in a salinity of about 17 ‰.

Equal in importance to *S. taty* is *Coilia dussumierii* C.V. which is the only representative of this genus in the mixing area. All other species belonging to this genus are purely freshwater ones.

Another dominating form — at least in some estuaries — is *Thryssa kam-*

2) Cf. Treubia XIV, 1932.

*malensis* (Blkr.), which in some localities occurs in great numbers and in others only sporadically for reasons unknown thus far. Anyhow it is a species not found outside our ecological boundaries. Of the other *Thryssa*-species only *Thryssa dussumieri* C.V. which is found regularly in small numbers, may be mentioned here.

Of the species of *Stolephorus* only *Stolephorus baganensis* Hardenberg seems to be especially confined to the tidal areas.

Of the true Clupeids only *Opisthopterus tartoor* (C.V.) and *Raconda russelliana* Gray are true estuarine species, though never occurring in great numbers.

A very important form in this biological group is *Harpadon nehereus* (Ham. Buch.), the so called Bombay Duck. Often a large percentage of the catch consists of this species.

The large genus of *Arius*, though common under estuarine conditions is not a wholly estuarine group. Of the Hemirhamphids only *Hemirhamphus georgii* C.V., must be mentioned here. It is at any rate very rare outside.

The flatfishes have two true estuarine forms, viz. *Typhlachinus caecus* Hardenberg, a species especially adapted to muddy waters with its blind eyes and furthermore the very common *Cynoglossus monopus* (Blkr.).

*Proteracanthus sarissophorus* Cantor seems to be found only under estuarine conditions, though it is rather rare.

*Kurtus indicus* Bloch is true estuarine and is very common, the same can be said of *Johnius dussumieri* (Cuvier) and of *Stromateus cinereus* Bloch, a species which is replaced farther in sea by *Str. niger* Bloch.

Typical are eel-like Gobiids as *Gobioides anguillaris* (L.), *G. cirratus* (Blyth) and *G. rubicundus* (Ham. Buch) of which the last one is found in much lower salinities than the two first. *Trypauchen vagina* (Bl. Schn.) and *Trypauchenichthys* species are to be mentioned here.

From the Gymnodontes only *Xenopterus naritus* Richardson belongs to this ecological association. Among the several species of sharks found only *Carcharius mülleri* Henle is common.

## B. COASTAL FISHES

To the coastal species I reckon those fishes which can be found not only in the estuarine areas proper but whose space of occurrence stretches also along other parts of the coast where no big rivers are but at the utmost small rivulets are found, provided that coast and seabottoms are muddy. Coastal species living on coralreefs, along rocky shores are naturally enough never living in estuarine conditions. In general the coastal group intentioned here can be found everywhere along the shores of the greater Sunda Islands, unless these coasts are bordered by the open ocean.

These coastal species do not spend their whole lifecycle in the estuaries, as young and adult can be found everywhere, though in some cases there seems to be an accumulation of juvenile specimens in the rivermouth areas proper.

The most important species will be mentioned in the following. Those are *Megalops cyprinoides* (Brouss.) and *Dorosoma chacunda* (H.B.) of which especially the latter is common. Among the true Clupeids the species of *Pellona* should be mentioned in this respect.

Many species of Silurids are found in estuarine waters and especially so several forms of *Arius*, which all are occurring everywhere along muddy coasts. Among the different genera of eels *Muraenesox cinereus* (Forsk.) and *M. talabon* (Cantor) are representative for the coastal group and the same can be said for *Tylosurus strongylurus* (v. Hass.) and several *Hemirhamphus* and *Zenarchopterus* species of a lesser faunistical importance.

*Eleutheronema tetradactylum* (Shaw) is always found in great numbers. It is probably propagating in the estuaries and young fry is numerous. Immature and mature individuals will be common everywhere else along suitable stretches of the coastline.

Several genera and species of the Sciaenids belong most probably in this group and in this case again the same can be said as for *Eleutheronema tetradactylum*. The most important is *Otolithoides biauritus* (Cantor).

*Trichiurids* viz. *Trichiurus glossodon* Blkr. and *Tr. savala* C.V. are certainly spawning in the estuarine areas or at last in the nearest vicinity in a seaward direction. Young as well as adult specimens are found anywhere else. *Tr. savala* is tolerating lower salinities than *Tr. glossodon*.

*Carangids* found in front of rivermouths belonging to the coastal group are relatively rare. The most common are *Megalaspis cordyla* (L.) and *Atropus atropus* (Bl. Schn.). In the family of the *Scomberids* only the genus *Cybium* is of some importance as a faunal element. *C. kühlü* C.V. and *C. guttatum* Bl. Schn. are to be mentioned in this respect.

*Sharks* are proportionally rare in the tidal waters with the exception of *Carcharias mülleri*. Henle, of which I am not sure whether it belongs to the true estuarine fishes or that it belongs to the coastal group. Among the skates and rays *Trygon walga* Müll. Henle is the most often seen. This is a common species elsewhere in Indian waters too. All species of the *Plagiostoma* are rather rare except the two just mentioned.

### C. SPECIES MIGRATING FROM THE RIVERS INTO THE TIDAL AREAS

In this category many Silurids can be placed especially the genus *Pangasius*, which members are only found in those parts of the estuary with a low salinity, viz. *Pangasius polyuranodon* (Blkr.) and *Pangasius nasutus*

(Blkr.). Other Silurids belonging hereto are *Cryptopterus hexapterus* (Blkr.), *Ketengus typus* Blkr., *Hemipimelodus macrocephalus* Blkr., *Macrones wolffi* (Blkr.) and *Macrones nemurus* (C.V.).

A few Cyprinids only are descending into slightly brackish water viz. *Rasbora argyrotaenia* (Blkr.), *Leptobarbus hoevenii* (Blkr.), *Osteochilus melanopterus* (Blkr.), *O. spilurus* (Blkr.) and *Puntius hexazona* (Weber and de Beaufort). The same can be said for *Septipinna melanochir* (Blkr.).

#### D. A GROUP OF SPECIES ASCENDING INTO THE FRESH WATER OUT OF SEA

Only two species should be mentioned here. Those are *Clupea (Alosa) toli* C.V. and *Clupea (Alosa) macrura* (Blkr.).

#### E. OCCASIONAL-GUESTS

Species belonging hereto do not need to be mentioned here. In every biological or oecological unit stragglers from elsewhere can be found. I refer in this respect to my paper: The Fish Fauna of the Rokan Mouth, Treubia XIII, 1931.

Within the estuaries themselves several biocoenoses can be distinguished. The catches of the fishermen are by no means uniform everywhere in a given area. It is outside the scope of this paper to treat with this subject in details. Too many factors regulating the distribution of the several species relative to this problem are still unknown and not every estuary is as intensively fished as for instance the Rokan Mouth.

In general it can be said that the lower the average salinity in a given area of an estuary the smaller the specimens of the true estuarine species. This for instance in the case with the *Setipinna* species, *Coilia dussumierii*, *Harpodon nehereus*, *Stromateus cinereus*, Gobiids and so on. It does not mean however that the fullgrown mature specimens of each species have the same optimum for its average salinity. The bulk of the mature *Gobioides* are found in the same regions as fry as young of *Stromateus cinereus* and *Setipinna taty* for instance, whereas most mature *Setipinna melanochir* are found in the region of young *Gobioides*. More instances can be quoted, but as my comparative notes are lost, these few will be sufficient. It is possible too that another factor than the average salinity, for instance the amount of silt, is to some extent of importance in some occasions.

In some cases the distribution of fry, young or mature specimens seem to be confusing at first sight as for instance is the case with *Stolephorus baganensis*<sup>3)</sup>. Closer examination however shows that we have to do here with

3) In literature *Stolephorus tri* Blkr. is mentioned for rivermouths. I could prove however that this is a different species which has been confused with my *St. baganensis*, *St. tri* is rather rare in rivermouths and it belongs to the coastal group.

two different races one living in a lower salinity than the other, whereas the fry and young of the latter is mixed with adult of the former.

The aestuarial fauna described above is, as already has been stated, confined to the coast of Asia proper and the adjacent islands Sumatra and Borneo and to a lesser degree, also on Java. This island has no big estuaries or rivermouths with one exception only, the Bengawan or Soloriver near Surabaia. All three islands are situated on the Sundashelf and were therefore part of the mainland within relatively recent times. However at the South coast of Java near Tjilatjap is one isolated area where estuarine conditions exists. It is there where the Tjitandujriver flows into the open Indian Ocean. Even after cursory examination one is struck by the fact that almost all true estuarine species are absent. One is looking in vain for such keystone species as *Setipinna taty*, *Coilia dussumierii*, *Stolephorus baganensis*, *Thryssa kammalensis* *Opisthopterus tartoor* and *Raconda russelliana*, *Harpadon nehereus*, *Stromateus cinereus* and others. Only *Gobioides* and *Trypauchen* is not absent, though probably belonging to other species and possibly undescribed ones.

Here the bulk of the landings of the fishermen consists of species, belonging to the coastal group. *Eleutheronema tetradactylum* is one of the most important. These specimens here belong most decidedly to another race as the specimens of *E. tetradactylum* found elsewhere. Here, when fresh, the fishes are bluishgray on the back and have a grayish caudal fin. Elsewhere in the Archipelago *E. tetradactylum* has a greenish back with a yellowish tailfin.

The supposition is tempting in this case to assume that the estuary of the Tjitanduj was isolated already in old geological times and the true estuarine species never were able to travel along the open ocean of South Java.

In this respect I have to mention another group of isolated rivermouths. On the southcoast of New Guinea on the Sahulshelf biologically the same estuarine conditions are found as in Borneo and Sumatra. Sahul- and Sundashelf however are wide apart from each other, isolated by the deep Moluccaseas where the small or rather small islands bear no big rivers. Salinities there are higher and the waters are clearer than in the shelf seas. Yet a true estuarine fauna is found at New-Guinea, of which I have only a few representatives at hand now as the greater part of the collections are lost.

This fauna is rich and has at first glance the same appearance as the fauna from the Sunda islands. Yet, at closer examination one finds that most species are quite different. *Coilia dussumierii* seems to be totally lacking as is the case with *Stolephorus baganensis* and *Stromatus cinereus*. Of the *Setipinna* species only *S. taty*, certainly another race, seems to have able to cross the Moluccan seas, but there is another hitherto undescribed species of the same genus.

*Opistopterus* and *Raconda* seem to be lacking but are replaced by a species which is the same in external appearance though it belongs to a totally different and new genus (to be published later and elsewhere). *Harpadon nehereus* is lacking and replaced by another still undescribed one<sup>4)</sup>.

Polynemids are partly the same and partly belong to undescribed species. *Kurtus indicus* is replaced by *Kurtus gulliveri* Casteln. This species is found in fresh water too. *Gobioides* species are common though not always the same as on the Sunda shelf.

It seems therefore that this rivermouthfauna of New Guinea has developed quite separately, though its roots must have been the same as of the Asiatic fauna. Much however is still unknown, as well as about the number of species as about their biology. I am of course thus far not able to place the known elements in the different ecological groups named above. A rich field of study in ichthyology remains still open here for future research.

Finally I wish to use this occasion to draw attention to the fact that according to me it is not impossible to find an estuarine fish fauna in other parts of the tropics, though nothing has been described in this respect thus far. The Amazon estuary, the Orinoco, the Rio Magdalena are such possible localities in South America and in Africa for instance the Rufidji on the East coast and the Congo on the west Coast. Eventual investigators should bear in mind however that the possibility of attaining all the relatively small species like those dealt with above, is to a high degree dependable from the fishing methods. It is not everywhere that we have such fisheries implements as the jeremal<sup>5)</sup> in the Rokan mouth which takes more or less indiscriminately all species of fish with the result that the catches give us a fair picture of the fishfauna as a whole. Hook and line fishing shows us the predators only and not for instance the planctoneaters. Fishtraps quite near the shore will exclude many species which live in deeper water only.

4) The genus *Harpadon* is probably originally a deepseagenus, which has migrated into estuaries. There is another example of this peculiar phenomenon in *Bregmaceros maceellandi* (Thomps.), which occurs in the deepsea as well as in estuaries. Specimens from these so quite different habitats are in all appearances quite the same! I have the impression that this lastnamed species is occurring only in those rivermouths situated on parts of the Sundashelf, bordering the deepsea, therefore is East Borneo and the North of Sumatra. I never saw it in Javasea- and South China Sea rivers. Should this be true then it can be expected only in the western part of South New Guinea and not towards the Torres Strait region.

5) See Treubia XIII, 1931.