
The Scheel Letters, No. 19

The Genus Nothobranchius

Possibly it might be considered an audacity trying to deal with this messy genus within the African killies. But as we keep several "species" now and possibly more will turn up in the future, I certainly take the risk diving into the problem, hoping that one day some skilled zoologist will try to put in order this confused group of fish. The Old World's Rivulinii (or Rivulinae) consist of the genera Aplocheilus (Asia), Epiplatys, Pachypanchax, Aphyosemion and Nothobranchius.

The genus Nothobranchius was erected by Peters in 1868 using *Cyprinodon orthonotus* which he described in 1844 from Mozambique as the type. For many years however the name in most cases was replaced by Fundulus (this name now is used only in connection with killies from North America) or Adiniops (now not in use). About 18-20 different "species" have been described by zoologists, but many might be races possibly of variable "orthonotus".

The distribution of the genus is very interesting. Indeed the main area of distribution is in coastal areas from Somalia to Mozambique, but a few species have been found far from the East African Coast. One typical Nothobranchius was found in 1933 in Gambia, about 200 km upstream in temporary rainwater pools by Svensson. Another (possibly more doubtful) species was described from Northern Nigeria and one species lives in the South Eastern corner in the Congo Basin. As these fishes mostly are rather small and live in temporary small freshwaters some species might exist somewhere between Gambia-Nigeria and the coastal waters in East Africa. One (or two?) species is found in the Seychelles Islands, but there are no reports of this genus from the lowlands of Madagascar.

To the aquarist the name of Nothobranchius means a small, rather deep fish being 5-8 cm long. Male with brilliant greenish to bluish metallic cast on the whole side of the body and head. Each scale should have a red edge or a red dot. These red markings forming a more or less regular net pattern along the sides of the body in particular on the hindmost part. As in Aphyosemion (their closest relatives??) there are "wormlike" red markings on the gill covers. Eye is brilliant green to blue. The vertical fins might be more or less covered by red dots or streaks in the dorsal and anal fin and in the caudal fin the red colour very often spreads in the way forming a completely uniformly red colour. The vertical fins might be edged with more or less black colour. In some species the ground colour of the dorsal and anal fin is yellowish. Dorsal and anal fins, in particular in the male, are big and rounded. They are used in the spawning act to keep the female in the right position as in Aphyosemion and other genera. No

pronounced rays in vertical fins. The female is uniformly brownish to greenish and might have more or less conspicuous dark dots in particular on the hindmost part of the body. It is very difficult to distinguish the small specimens of females *Cynopoecilus ladigesi* from p.i. small specimens of *N. "palmquisti*". If in doubt, look at the hindmost edge of the dorsal fin; "ladigesi" uses to fold that edge in a particular way.

In nature these fish live in stagnant small freshwaters which possibly dry out during the dry season. These waters mostly are found in the open country exposed to the sun. The pools were described as dirty and water as turbid (Henry Hansen) and temperature might vary greatly in these pools. The chemical composition of the waters is not very well known and also no doubt vary greatly within the period in which the pools hold water. It is interesting that the Gambia species exclusively was found in the rainwater pools and not in the neighboring pools which had some sort of connection with the Gambia River during the rainy season. The natural conditions for the Nothobranchius possibly are not far from those of the Cynolebias in South America.

In aquaria all hitherto imported species showed great weakness and all might be considered among the most difficult and feeble aquarium fishes we ever kept. They might be considered as a standing challenge to our capability as aquarist. Their weakness in particular seems to be connected with the sexual maturity and at that time mass dying often occurs and often without any warning at all. In the dead bodies lots of bacteria of the tuberculosis type were found whenever I dissected. I was not able to stain these bacteria, not even by prolonged use of boiling Carbol-fuschin. The bacteria measured up to 20 _ (1_ = 1/1000 millimeter) and therefore might be considered not as a real bacteria but more as a primitive sort of fungus. This disease often called "fish tuberculosis" no doubt is a typical "aquarium disease" which we are not able to avoid whatever we do.

It is interesting that guppies might be just as feeble as Nothobranchius under certain conditions. A few years ago I made up my mind to study the various genetic sex linked factors (for colour and pattern) in guppies in order to find out if the many factors described by Winge, Goldrich, Harris, a.o. solely were responsible for the colour pattern in modern guppies. But at that time all my tanks had standardized "rainforest water" (the type was equal to the present type but without any NaCl added). Under these conditions my many breeding stocks of selected guppies behaved as most difficult fishes and in particular the "fish tuberculosis" was a pest. In some cases even under the best conditions the guppies died by up to 10% of the stock a day. No medicine used gave any results. Not even the parachlorophenoxyethanol so effective against fungus and fungus-like organisms. The best way to save the guppies from dying completely out was to keep the water clean and plants at healthy growth. Indeed if removed to tap water tanks there were no problems, but I did not want to change my about 3000 liters of special water to ordinary tap water. In some of the big tanks with old peat mud in use for several years normally nothing happened to the guppies. Also I found that a handful of very acetic peat-like mud from the small swamp connected with the "river" of Moelleaen which flows near my house very often could stop mass dying in the stock of guppies if only I stirred this "dirt" into the water. Possibly certain antibiotic producing organisms in the dirt acted. My Nothobranchius when dying are showing the same pattern of behavior as did the guppies, they are growing very thin, they wriggle and tremble, they are nervous or blunt. No doubt the cause of their death is just the same as in the guppies and other killies.

The typical Nothobranchius in nature possibly lives without any connection to the main fauna of

freshwater fishes of the country. Maybe we find the particular weakness of the various species not only in the diverse conditions (compared with conditions in nature) in tanks but also in certain parasitic organisms not present in their natural waters.

As I now once more try to raise my stocks of Nothobranchius I was forced to use copper (solid, a net) in connection with the aquarium water. Not for the whole period of growth, but at once I spot the trace of Oodinium (thin white pattern on scales, in particular on head). This helps very much but it should not be a permanent solution of the problem. We severely need developing of a special aquarium type for the fishes of this interesting genus. When the specimens have passed the difficulties of maturing they very often are rather hard fishes and might live for a long time. My first pair of "melanospilus" (came in as eggs from Jack Scheidnass in 1958) lived for about 11 months. But he had a crisis now and then about the maturing period. Also adding of common salt to the water seems to be a solution, although neither this is not very natural indeed. Normally aquarists add 800 to 1200 ppm (mg/l) of NaCl, but up to 1650 ppm have been in use.

Well, I try to keep the tanks and the water very clean, changing water and peat at once when blue-green algae occur. But my friend Claus Peteron in 1958 raised possibly thousands of *Nothobranchius guntheri* in tanks which not at all could be considered as clean and which did not have any plants. These fish also were heavily crowded. I know that he had some difficulties, but possibly not more difficulties than I had in my "clean" tanks. Also the information given by Henry Hansen on his collecting of Nothobranchius rachovi in the backland of Beira, Mozambique shows that these fish in nature may live under very dirty conditions in very polluted and turbid water. Possibly there is no particular temperature problem. 16-25_C.

The aquarium-kept species are guzzlers. They consume enormous lots of food if you do not ration the supply. They prefer live food and coarse food indeed, but you might train them to eat any dry food normally used for aquarium fish. Also they grow very quickly from the hatching and until maturity. But after maturity possibly most of the food is used for the production of sexual cells. They then are growing rather slowly. The great consumption of food makes the maintenance in aquaria (if clean conditions are wanted) difficult and therefore the tank possibly should not be too small and the plants and light plentiful.

The spawning act takes place at the upper layer of the bottom peat or sand in a way much like the Aphyoesmion in the "gulare group". Some of my pairs "guntheri" and "palmquisti" use to dig hollows in the fine mud used but I am not sure if they did this purposely or if these hollows only came from repeated spawnings at the same place. The bottom of their tank was like the moon's face.

The eggs from "palmquisti" and "guntheri" are small (about 1.0 mm outside) whereas eggs form the "melanospilus" and "kuhntae" are much bigger being about 1.3 mm (1.3 x 1.3 x 1.3 = 2.2, that will say that eggs of the species last mentioned have a volume 2.2 times the eggs from the species first mentioned). Also fry just hatched are of proportional sizes. 3.5-3.7 mm in "palmquisti" and "guntheri" and about 5.2 in "melanotaenia" and "kuhntae". Egg "rachovi" see page 71. Egg surface has a hair structure which differs from the other African aquarium kept killies. The filaments on membrane are short and stiff, often standing bristly out from surface and superficially they remind of eggs from

"Cynopoecilus" which these species in so many respects remind of. Eggs are rather transparent and easy to inspect as they do not adhere any particles of peat. Odd enough eggs Oryzias latipes also have such stiff hairs. The various phases in the development of eggs are not very well known. On low water the free entrance of air samples of eggs (palmquisti and guntheri) most did develop and were ripe after about 4 weeks. The two other species did not develop so willingly and may stay transparent most of them for much longer time even under these favorable conditions. They then stop at the phase of "resting embryo". Hard egg drying up at once after collecting of eggs seems to force many if not all eggs into the phase of "resting eggs" (or resting embryo?), whereas a more moist drying seems to act as the keeping on low water. More investigations are needed.

Resting fry is the normal phase of eggs kept on shallow water, but now and then some eggs do hatch normally giving us belly sliders. However such hatchings also give a few normal swimming fry. Resting fry are easily hatched by adding dry food, but the percentage of belly sliders then is very high.

Summary of the Species described 1) N. amsinki (described by Ahl in 1929) the paper is not in Copenhagen.

2) N. brieni (described by Poll in 1938) this is a typical Nothobranchius in the aquarist's sense. It was caught at the southeastern corner of the Congo Basin, not far from the territory where Congo freshwater fauna mixes with the East African fauna. The locality is given as pools (?) near the river Lualaba, near the National Park, near Bukama. 6 cm. The colours of the live fish are not known. Preserved specimens (males) have red dots on each scale, these dots forming a more or less regular pattern and vertical lines. The vertical fins, in particular the dorsal fin, are dotted with red. The anal fin has a broad red band and its edge is black. Female has very weak dark dotting on sides. Poll's figures show us a typical, rather robust Nothobranchius. Never imported.

3) Nothobranchius eiminii (???) (described by Ahl in 1935 only on one specimen, possibly a female). Near *N. rachovi*. 6 1/2 cm. Hindmost part of the body and the vertical fins are dotted with dark colour. Caught at Konoran-Bott in Tanganyika (can not find this locality on my maps).

4) Nothobranchius gambiensis (described by Svensson in 1933 and much more in detail by Johnels in 1954) A typical Nothobranchius in our sense. Sides of male are brilliant azure with irregularly distributed, big red dots. The gill covers are red. The vertical fins are orange with deep red border. The female is brown with few dark dots on fins and hindmost part of body. 5 cm. Caught in rainwater pools very near the River Gambia. Who knows somebody in Gambia?

5) Nothobranchius guntheri (?) (described by Pfeffer in 1893 on some specimens in the Hamburg Zoological Museum) Zanzibar and possibly also on the coast opposite the Island. The best known species in tanks. Male has brilliant greenish blue metallic cast on sides of body and head. Each scale is edged by red and these red lines on the hindmost part of body (at least in the recent aquarium stock) form vertical red bars. Dorsal and anal fin have a yellowish ground colour heavily dotted with red or brown and these fins have more or less blackish edge. Caudal fin is brilliant red and edged with rather broad black band. Female uniformly brownish with no dark dots. Specimens grow up to 85 mm. Imported (Germany in 1913 and several times later the recent stock came in 1957?).

6) Nothobranchius kiyawensis (described by Ahl in 1928 on one male and one female) Colours of the live fish are not known. 5 cm. Caught in (by?) the river Kiyawa near Katagum in Northern Provinces in Nigeria. This locality is logically compared with the "gambensis", but from Ahl's description it is not easy to find out how this fish stands to "gambiensis".

7) Nothobranchius mayeri (??) (described by Ahl in 1935) Typical Nothobranchius, with dominating red colouration on fins and body, mostly (possibly) by a further development of the red edges on scales and dots in fins. Ahl wrote that this species stands close to his "kuhntae", but as "kuhntae" is identical with "orthonotus", this species possibly also is a race of "orthonotus". 7 cm. Female also has a red cast on sides and fins. Beira in Mozambique. Imported to Germany and possibly re-imported in 1958 (Roloff?).

8) Nothobranchius melanospilus (??) (described Pfeffer in 1896) This is a typical Nothobranchius. Male has brilliant metallic cast in blue to greenish blue on sides and head, but the brilliance varies (apparently) more in this species than in the other aquarium kept species. This variation seems to have something to do with the health of the fish but possibly also some males always are more brilliant than others. In this species (I mean the fish now kept in aquaria = Scheidnass' stock or Henry Hansen's stock) the red pattern of the red edges of the scale forms a very regular net pattern on the sides of the body in the male (just like in "palmquisti"). The dorsal and anal fins often are edged with white and there is much red (and black) in these fins. Caudal fin is deep red and has on hindmost part a broad black vertical band. 6 cm. Female has conspicuous dark spots on hindmost part of body and the dots seem to concentrate near the sideline and may enter into the root of the caudal fin. Has been confused with "seychellensis". Caught in Tanganyika near the coast. Imported to the USA (H. Hansen) in 1955.

9) Nothobranchius microlepis (described by Vinciguerra in 1897) Might be a typical Nothobranchius (I have not had time to make a complete translation of the original description). Only two preserved specimens are known. 5-6 cm. Locality: "raccolti nello stagno Saha, sotto il monte Egherta, tra Brava e Lugh". Somalia.

10) Nothobranchius neumanni (?) (described by Hilgendorf in 18??) I have not red the original description yet. East Africa.

11) Nothobranchius orthonotus (described by Peters in 1844) Type species of the genus. The sides of body and head are bluish green in male. There are lots of red dots on the sides giving these a reddish cast. Vertical fins also are rather reddish and have (dorsal and anal fins) deep red edges. Female also has reddish cast, rarely in the fins. 7 cm. Caught in southern Tanganyika and northern Mozambique, near the coast. Possibly this species is identical with the one kept in Germany since 1957-58 under the name of "kuhntae" (my stock came from Griem, Aquarium Hamburg through my friend C. Petersen). Female reminds of female "melanospilus" but in this "race" there are not so many dark dots and these are not concentrated near the sideline on hindmost part of body.

12) Nothobranchius palmquisti (??) (described by Loennberg in 1911) A typical Nothobranchius (I mean the "species" now kept under this name in tanks) very close to "guntheri". The pure stock might easily be distinguished from the stock "guntheri" by two factors at least: 1) this species does not have any black

pigmentation on hindmost part of caudal fin, which is plain red. 2) in this fish the red net pattern on sides of male is very regular, not forming vertical lines on hindmost part of body. Also there is less black and red in dorsal and anal fins and the straw orange yellow colour on lower parts of body and head plus dorsal and anal fins are much more intense in this fish. 4-5 cm. Loennberg's specimens came from Tanga in Tanganyika. Female is plain, without any dark spots and is more greenish than female of "guntheri", but if one does not have live specimens of both "races" present it is very difficult or impossible to find out whether female is a "palmquisti" or a "guntheri". Imported by "Tropicarium", Frankfurt in 1957.

13) Nothobranchius patrizii (described by Vinciguerra in 1927) Might be a typical Nothobranchius, Vinciguerra compares with "palmquisti". 3-4 cm. Caught at river Juba in southern Somalia.

14) Nothobranchius rachovi (described by Ahl in 1926) The colour pattern of this small species differs greatly from the "typical" Nothobranchius. There is much red and orange all over the body of the male. On hindmost part of body and vertical fins there is a brilliant greenish bluish cast. Caudal fin has hindmost a black edge and close to this a brilliant orange vertical band. Lower parts of body and head are orange to orange red. Female plain (in the specimens I keep now there is little greenish cast in dorsal and anal fin). 6 cm. Mozambique (near Beira) but possibly also in Rhodesia. Imported to Germany in 1925, also several times after 1950 to USA and Germany. The present stock (which might spread around the world by our organization) might be called Roloff's stock.

I have collected the first eggs and found them identical with eggs from "guntheri" and "palmquisti". Same pattern on membrane and same size (0.95 x 0.85 mm or 1.05 x 0.80 mm, not quite circular).

15) Nothobranchius robustus (??) (described by Ahl in 1935) Only one preserved specimen is known. A male. The colouration of the live fish is known. Blue with brown edges of scales and brownish red fins. The preserved fish was plain having a black edge on dorsal and anal fins. 52 mm. Caught at Tshangarra, Northern Usinja, Tanganyika (can not find this locality on my maps).

16) Nothobranchius seychellensis (??) (described by Ahl in 1935 from old material) Near "guntheri" and "melanospilus". Only the female is known. She was brownish with black dots on hindmost part of body. 55 mm.

17) Nothobranchius taeniopygus (??) (described by Hilgendorf in 1888). Male has red edge on all scales. There are red dots on head, the sides of body and on the dorsal and anal fin. Caudal fin is red. The hindmost part of body and also dorsal and anal fins are doted with black in the female. Caught south of lake Victoria.

18) Nothobranchius vosseleri (??) (described by Ahl in 1926) I have no further information yet. Special articles on the present species (or races) kept in aquaria will be prepared.

Crossing the species at hand

For these crossings I had the pure stocks of "melanospilus" (Hansen's stock), "guntheri" (Griem's stock) and "palmquisti" (Tropicarium stock). Also a male "rachovi" (came in from Griem in 1958, possibly this male belongs to Roloff's stock??) All these (three first mentioned) stocks breed true:

- Nm/Ng (09-17 July 58) Many eggs spawned.
- 02 Aug. 58: development of embryo in eggs for control, also circulation of blood elements. Hatched one fry but it died before maturity. Possibly my fault. Most of the eggs decomposed. Further experiments are needed, but apparently this cross is very difficult.
- Np/Ng (17-23 Aug. 58) Many eggs spawned. Eggs in water showed a normal development of embryo.
- 28 Sep. 58: embryo had black eyes. Hatched many fry from eggs dried up, some came near maturity, but "my spirit was lost at that time" and they died from tuberculosis. This combination seems to be the only good one and no doubt many present stocks of "palmquisti" are "hybrids", made Np/Ng.
- Nm/Ng (14-26 July 58, 17 July-02 Aug. 58, 02-17 Aug. 58) Three spawnings, each containing lots of eggs. I have not hatched a single fry from these samples, nor did any of the many eggs inspected under the microscope show any trace of embryo. Many eggs still were intact Christmas 58, but in the eggs the yolk was falling into oil drops.
- Ng/Np (one spawning) Just like Nm/Np. No trace of embryo in any egg.
- Nr/Np (20 eggs from C. Petersen who owned the male Nr) Just like Ng/Np and Nm/Np. No trace of development in eggs before they decomposed after months.
- Ng/Nm (until 31 Aug. 58) Many eggs, just like crossings with female Np, no trace of development in any egg for several months.
- Np/Nm (until 07 Sep. 58) Lots of eggs spawned. Like Ng/Nm.

No results for several months storing of these eggs both in water and in dried peat. These crossings with totally many hundreds of eggs spawned are not at all promising indeed. I do not know any explanation for the missing of development in most crosses, because compared with p.i. the Epiplatys-Aphyosemion crosses at least some development of an embryo should be expected. Perhaps some factors unknown to us and governing the development of eggs in "annual killies" plays a role as apparently also in the three crosses in Cynolebias. Before we know more on the factors governing the development of eggs in the "real annual killies" it might be waste of time and eggs to repeat the crossings already made. However it might be of value to those breeders who still hold the pure stocks of "palmquisti" and "guntheri" to try the Ng/Np and Np/Ng crosses in order to inspect the offspring, but naturally these "hybrids" should not be mixed up into the pure stocks.

Ecology of Nothobranchius in Mozambique

1) Dr. Rolf Geisler: "Zur Kenntnis des Lebensraumes..." in Bulletin of Aquatic Biology, Vol. nr. 4 (June 59)

2) E. Roloff: "Collecting and breeding the Nothobranchius species" in Tropical Fish Hobbyist Vol. 7 nr. 10 (June 59) Ecological data for Nothobranchius are few, but as the keeping of these fishes still might be considered as rather difficult, any information on the natural conditions might be of importance. Here is shortly some information connected to Roloff's collecting N. rachovi and Nothobranchius species near Beira, Portuguese East Africa. The stock "rachovi" (let us call it Roloff's stock) seems to be the sole stock of aquarium kept "rachovi" and they are accordingly to information I recently got from Dr. W. Ladiges identified...

In July 58 Roloff flew to Beira in order to collect some Nothobranchius. It was during the coolest months he arrived and the many pools in the swampy area around Beira were drying out. About a mile from the edge of the city he found his first Nothobranchius in a ditch which ran alongside a road. This ditch was almost dried out and held water only in the deeper spots. Sedges grew along the bank and the stalks and roots reached into the water. The bottom of the ditch was covered with a layer of half decayed plant fibres which reached up into the lower layers of the water. It was not difficult to discover the males because of their bright colours. Catching them was more difficult than he had appreciated because the fish fled into the sedges and also into the plant fibres... In the ditches he also found another Nothobranchius species... Well, Dr. Werner Ladiges has inspected specimens of both species which Roloff caught during this trip. He found (information in a letter from Dr. Ladiges) that the "rachovi" is identical with the original "rachovi" (Ahl's species, 1926) but the other species (one colour photo and a black-white one in TFH) is more doubtful, not that it is a real Nothobranchius, but to what species it belongs. Roloff himself writes: "The possibility exists that there are two additional species (apart from "rachovi"). The scientific name cannot be determined as yet because there are still some discrepancies to be cleared up. For this reason I am delaying mentioning the names of these species which were caught with N. rachovi until they are definitely identified". One of the black-white photos in TFH shows a N. melanospilus (?). Photo by E. Roloff. Geisler's article mentions only one species besides "rachovi" and informs that this one might be "melanospilus" (according to Dr. Ladiges).

However the real name might be of less importance as long as we know what stocks we deal with. Therefore I will not use the name of "melanospilus" in connection with these two "species" because this name recently has been used upon "Henry Hansen's Notho" and because this name (at least among Danish aquarists) is fixed upon this fish until we might get the "real" name. In a letter (May 59) Dr. Ladiges kindly informed me on the various aquarium kept Nothobranchius inside Germany. Ladiges also connects the name "melanospilus" to Hansen's species which was brought into Germany as eggs via Jack Scheidnass. The two forms which Roloff brought home from Beira have provisionally got the names of "orthonotus" and "mayeri". "mayeri" being the "red form". As far as I can find out no other stocks of Nothobranchius came into Germany in 1958. That will say that the form that I hitherto named (in letters etc.) as "kuhntae" is the same as "orthonotus" (Roloff's stock). "kuhntae" I got (as eggs) from Claus Petersen who got the breeding pair from "Aquarium Hamburg" in 1958 together with a pair of "rachovi". "mayeri" (Roloff's stock) I have not seen.

That will say (if the "Aquarium Hamburg stock" of "kuhntae" is identical with "Roloff's stock" of "orthonotus") that the ecological data might be used on the following aquarium kept stocks:
1) "rachovi" (Roloff's stock , the sole one kept just now)
2) "orthonotus" (Roloff's stock = "kuhntae" Griem's stock)
3) "mayeri" (Roloff's stock, a fish with more red colour than 2) and besides these 3 forms we also keep:
4) "guntheri" (Griem's stock, probably sometimes mixed up with 5)
5) "palmquisti" (Tropicarium stock, the small one which I sent out in 1958)
6) "melanospilus" (Hansen's stock or Scheidnass' stock, very close to 2-3)

Together with the 2 (3) species of Nothobranchius he found some single specimens of *Puntius (?) paludinosus* and some young Tilapia. These were obviously from neighboring streams and had been stranded there by the receding waters eventually to share the cruel fate of the Nothobranchius species

when the waters dried out altogether. Further excursions to other freshwater ditches and swampy pools in Beira brought to light more of the same Nothobranchius species. They were found together, rather than each species in its own water hole. This was not surprising because in the rainy season the whole region becomes one large lake and the fishes can spread out all over. He measured the temperature in the places where he was successful and found it to be 68_F in the morning, rising to about 77_F in the course of the day. It must be remembered in this connection that he visited Beira during the coolest months (see later). In the hot months the temperatures are considerably higher... For the sake of thoroughness, let me say that the Nothobranchius species are found only in freshwater and not in brackish water. Roloff remained in Beira until 27 July 58. By this time most of the places where he had found fishes had dried out completely. Natives told him that in other years these places had dried out weeks earlier. There was exceptionally heavy rain in 1958. The rainy season begins in November in Beira. Because many holes where Nothobranchius occur dry out as early as June it can be assumed that the eggs lie in dried out places for usually 5-6 months, until the rain permits the first youngsters to hatch. The region around Beira is very swampy. The eggs are prevented from drying out completely by the night dampness. Roloff left Beira with 300 specimens of Nothobranchius and arrived in Karslruhe in Germany with only 100 specimens. Many eggs were spawned in the cans. Geisler analyzed the sample of water which Roloff brought back to Germany. Water sample was collected on 27 July 58 at the place where Roloff found his Nothobranchius. Analysis was made 10 Oct. 58. Sample came in inside glass bottle. The sample was clear with light yellowish colour. After several days of standing (with free air entrance) brownish, amorphous fluffs settled. No particular smell.

pH 7.1
Temporary hardness 6.1 German Degrees
Total hardness 8.3 German Degrees
Chlorine (as Cl-) 61 ppm (or mg/l)
Nitrate (as NO3) 27 ppm
Iron total (as Fe) 11 ppm
Silicate (as SiO2) 11 ppm
KMNO4 consumption 58 ppm (after filtration)
Solids at 105_C (?) 202 ppm (residue after evaporation)

It must be remembered that this sample was taken at the time when the pools were about to dry out and therefore represents possibly the highest concentration of any solids present in the natural water.

As we know the temporary hardness of this water being 6.1 DH we find the alcality to be 6.1:2.8 = about 2.2. Also as no organic acids might be present in a sample with an alcality like that we might estimate the concentration of carbon dioxide using a particular graph (I use Ruttner's) and we find about 20 ppm of CO2. Shallow water under the conditions described might not hold such large amounts of CO2 (in the sample the height concentration might come from the decomposition of some organic components). Estimating a "natural" concentration of 1 to 5 ppm CO2, the corresponding pH would be above 7.1 also above 7.6 (5 ppm CO2 correspond with pH 7.7). 61 ppm of chlorine corresponds with 61.58 1/2/35 1/2 ppm of sodium chloride. Geisler also analyzed a sample of the bottom "mud" from these pools and found about 90% of coarse, peat like remains of vegetation (roots, remains of stems etc.) and about 10% of coarse sand. As this sample was taken using a coarse net the fine particles possibly escaped. In water this

sample gave a neutral reaction (pH about 7.0 as the water sample).

Here we find the data for Beira.

Kendrew: "The Climates of the Continents" 1953

Month	Mean Rainfall		Mean Temperature	
Jan.	10.3inches	258mm	81 F	27 C
Feb.	9.6	240	81 F	27 C
Mar.	9.5	238	81 F	27 C
Apr.	4.4	110	79 F	26 C
May	2.5	63	76 F	24.5 C
June	1.3	33	73 F	23 C
July	0.8	20	72 F	22.5 C
August	1.0	25	73 F	23 C
Sept.	0.6	15	75 F	24 C
Oct.	1.6	40	78 F	25.5 C
Nov.	4.7	117	82 F	27.5 C
Dec.	9.5	238	82 F	27.5 C
Year	56.4	1410	78 F	25.5 C

In the winter (Apr.-Nov.) the equatorial trough is far in the North of the continent and the SE trade wind blows on Portuguese East Africa. In midsummer the equatorial trough has returned to the southern hemisphere bringing the NE monsoon to this country down to Beira. The monsoon brings moist air and gives away much rain. The rainfall is heavy and of the normal tropical type. During the 3 summer months the rainfall is more than 50% of the annual rain and also more than 80% of the summer rain. Winter is not without any rain even as this time of the year is the dry season. In winter the temperature is rather high and also rather constant. This is caused by the warm currents of the sea, giving away hot and moist air. If water pools normally still hold water during early or middle July, the real dry season possibly will be ended in Nov. or at least in Dec.

We should not forget the article of Henry Hansen in the Apr. 1957 issue of "The Aquarium" ("Let us go on African Safari"). I shortly take some data from that article: Hansen arrived at Beira and stayed there for 6-8 weeks. A local big-game hunter informed him that the best bet would be to go inland and inquire from the native Machangani or Sena boys. He then boarded a small bus which was running inland through several native villages. They drove through several small villages and when the bus stopped at a restaurant and tavern he decided to start his searching there (4 bus hours from Beira, that is max. 50 miles from that city). He had difficulties in making the natives understand what fishes he was looking for and also his searching in the various waters did not bring him any Nothos. However at last a woman brought him a fine male "rachovi" in a small rusty tin. She caught that fish in a mud hole next to her hut.

The rain had stopped the next morning and Hansen went to the mud hole. Her hut was situated near a low stretch of grassy land lying between the big river and the road, which was used by the bus. The small mud hole was "full of rusty cans and junk" and Hansen could hardly believe that the "rachovi" came from that hole. Water was maybe 18 inches deep and so muddy that one could not see an inch into it. Having taken away most of the trash he seined the hole and in the first try he got a couple of dozen small fish ("rachovi" and "kuhntae") and a single young lungfish. Almost every native hut had some kind of waterhole close to it, most of them used for drinking and cooking water during the rainy season. A few of these holes had clear water in them and he never caught any fish in these, but always in the dirty, muddy looking holes. After a few days of good fishing the rain started again and it poured down steadily for about three days and everything flooded again. In fact, most of the area was more than a foot under water. It was impossible to spot the waterholes... Hansen introduced a small number of these fish in the USA, but no doubt no aquarium stocks were established... However he came back to East Africa in 1955 and caught hundreds of "guntheri" in Tanganyika. These fish formed the aquarium stock which I call "melanospilus" (Hansens stock).

Ecology of Nothobranchius in Gambia

Indeed we still have not got the Gambia species of Nothobranchius in our tanks. However the information about the ecology of the Nothobranchius gambienses might be of importance to aquarists and as I never saw any information about this species in aquarium literature. I shortly drew some information from the two big papers of Svensson and Johnels on the Gambia fish fauna.

1. Gustav S.O. Svensson "Fresh Water Fishes from the Gambia River" in Kunigliga Svenska Vetenskabsakademiens Handlinger 3. series, Vol. 12, 1934. The country on both sides of the Gambia River is flat or slightly wavy. Only at the upper course of the river there is no river valley and the naked ironstone rocks frame the river. On the lower course the walls of the valley are low, about 1 1/2 meter at lowest water level whereas the walls at the upper part of the river are up to 12 meters. Some parts of the whole river valley are situated a little lower than the banks of the river bed and therefore the big grassy swampy areas exist during the rainy season. Also outside the river valley such swampy areas exist in the naked iron rocks. These isolated swamps are only filled up with rainwater and only tadpoles and no fish are found in those swamps outside the valley. These swamps also have no outflow. The tide of the Atlantic brings brackish water 180 km up the river and the influence of the tide might be traced within whole Gambia. The brackish water does not reach the MacCarthy Island where Svensson had his camps. When he (Svensson) arrived at MacCarthy Island on 21 May 1931, the whole island was "dry as a bone". He gives the following data for the rainfall in 1931 (values in millimetres, 1 inch = about 25 millimeters):

05 Feb. 6.5

25 Apr. 1.8

07 May 2.8; 24 May 1.5 13 June 0.2; 15 June 7.8; 17 June 0.8; 21 June 2.8; 22 June 3.8; 23 June 26.2

01 July 1.8; 09 July 14.0; 11 July 31.7; 13 July 6.1; 16 July 0.8; 18 July 18.8; 20 July 20.6; 21 July 36.8; 22 July 4.8; 23 July 5.6; 24 July 1.0; 25 July 20.3; 26 July 40.6; 28 July 3.8; 30 July 4.6

06 Aug. 10.7; 09 Aug. 3.0; 10 Aug. 7.1; 12 Aug. 1.0; 13 Aug. 78.5!;15 Aug. 75.7!

17 Aug. 6.9; 23 Aug. 2.8; 28 Aug. 1.3; 29 Aug. 18.5; 31 Aug. 33.3 01 Sep. 0.8; 06 Sep. 20.6; 07 Sep. 27.4; 08 Sep. 3.3; 09 Sep. 15.8; 10 Sep. 21.1; 11 Sep. 8.9; 13 Sep. 29.7; 16 Sep. 14.7; 17 Sep. 3.0; 20 Sep. 18.0;23 Sep. 14.0; 25 Sep. 16.5; 28 Sep. 1.0

01 Oct. 39.4; 02 Oct. 31.7; 09 Oct. 11.2

During the rest of the year 1931 no rain fell. The total rainfall was 788.1 mm. On the MacCarthy Island he found totally 72 different species (!) of fish and at least 50 of these entered the swamps of the island during the floods of the rainy season. During this time the landscape changes highly. Large areas of the low country around the river are flooded by rainwater and other areas with a mixture of river water and rainwater. These areas are used by natives for growing rice. Other swampy areas have stiff grass or other vegetation. Many swamps held water in Dec. but the connection to the river water was broken in Oct.-Nov. Svensson gives information about the collecting of his 72 different species. He found 4 Killies: Fundulus gambiensis, Panchax senegalensis, Panchax steindachneri and Aplocheilichthys gambiensis. Only P. senegalensis was known before. He only caught one specimen of F. gambiensis (a female, 47 mm total length) which was taken on 26 Oct. in a swamp. In 1950, another Swedish expedition arrived in Gambia in order to complete the research made by the Svensson expedition.

2. Johnels, Alf. G. "Notes of Fishes from the Gambia River" in "Arkiv for Zoologi. Vol. 6, Nr. 17". This expedition made their camp near Bansang on the Southern Bank of the Gambia River, about 300 km from the mouth of the river. The difference between the high tide and the low tide (dry and rainy season) is about 6 meters. The banks are about 2 m and often they have a small rim of trees. Very often the surrounding landscape is somewhat lower than the banks and these areas are flooded by the river during the rainy season and are used as rice fields or are transformed into swamps. Johnels gives the following information about the rainfall of 1950 (I give the corresponding data for 1931 also):

	1950	1931
June	38 mm	30.6 mm
July	199 mm	211.3
Aug.	308 plus?	228.8
Sep.	179 plus?	194.8
Oct.	92 mm	82.3
Nov.	17 mm	0.0

Temperatures in _C: Gambia River: 29.6 (03 Aug.), 28.1 (14 Oct.), and 27.1 (19 Oct.). Swamps and Creeks: 27.4 (03 Aug.), 24.5-31.0 (13-15 Oct.). The bottom of the swamps is solid and covered by a layer of soft mud which normally is about 25 mm deep. In the rainwater swamps the water is very clear and without any colour. Only the rainwater swamps in this area had specimens of Nothobranchius, but I also want to point out the conditions in the swamps which are flooded by the river's water in order to point out the conditions which the Nothos. in this area do not like. Unfortunately, Johnels did not measure the chemical composition of the water in the rainwater swamps where he caught his specimens of Nothobranchius.

pH of the water in the Gambia River was nearly constant between 7.0 and 7.5 from July to Oct. In the swamps and the connecting creeks he measured values (11 different values are given) from 4.9 to 7.0. He only informs that the water in the rainwater swamps always is acetic. Alcali-reserve was measured in the swamps. 0.0006-0.0008 (that is 0.0006-0.0008 equivalents per liter or 0.6-0.8 milliequivalents (meq) per liter. As 1 unit of alcality (alc) corresponds to 1 ccm of 0.1 N HCl/100 ccm we have that the alcality of the water was 0.6-0.8, corresponding to 1.7 to 2.2 temporary degrees (German) of hardness). Bromocresolgreen was used as indicator together with 0.1 N HCl and a Lovibond Comparator.

Fundulus gambiensis (a good picture shows us a typical Nothobranchius) was frequently captured. Accidentally, however, only 6 specimens came back to Sweden. The male differs from the female (Svensson) being little deeper in relation to length and more compressed from the sides. The middle rays of the anal fin are longer in the female. The caudal fin is rounded in the female, but more or less trilobate in the male. Female is greenish, uniformly dotted with brownish above, a few violet brownish spots on the sides, fins sparsely dotted with brownish. Johnels found that the brown colour is more dominant in the live females. Male is very strikingly coloured, he is a "gaudy beauty" to cite Myers (1952, on N. rachovi). The body is a light azure, at some angles with a greenish luster, sparsely dotted with dark brown. The back is slightly shaded with brown. The head is dark brown with blue or blue green spots. The gill covers are yellowish red, the branchiostegal membrane dark brown. The fins are all orange coloured, the dorsal, anal, and caudal in addition distinctly edged with deep red. The anal is dark at the base, the dorsal spotted along the lower half.

The species was mainly caught in the Dobbo swamp where it is crossed by the road to the village of Dobbo. During the time between 26 Sep., when the locality was discovered first, and 19 Nov. the place was visited 9 times and every time specimens of only Nothobranchius and Protopterus (lung fish) were captured and no other fishes. On 20 Nov. a number of Nothobranchius were caught where the upper part of the Alikiama swamp is traversed by the road to the village of Bantanto. Both these localities have one thing in common: they are not influenced by the river water -at least they were not in 1950. The water was perfectly clear, unfortunately no observations on the qualities of the water were made (at 10.30 a.m. on 19 Nov. the temperature in the Dobbo swamp was 25.6_C and the oxygen saturation was 91.5%) but it may be assumed that the water in such localities is acetic and soft.

Johnels comes to the conclusion that Nothobranchius is an annual fish in the sense of Myers (1952) and that the eggs from this species are more or less out of water for about 8 months. He points out once more that they never found this species outside the pure rainwater swamps and those specimens which are tried to be kept in an aquarium died within a few days. These tanks were filled with water from the river or swamps at the silver side. He found this species close to Fundulus walkeri and writes that this may indicate that the latter species should be referred to the genus Nothobranchius. Johnels' specimens are not bigger than Svensson's female, indeed most are smaller.

Both papers used for this small introduction to a little known Nothobranchius are in English and give a lot of valuable information on the great fish fauna of the middle Gambia River.

General Information on Peat

Early in 1958 I prepared a small article on the Use of Peat and Peat moss in the Aquarium Keeping and sent it to a few foreign aquarists with whom I cooperated in the Killie question. Well, I certainly mailed all copies and did not reserve any for the possible production of more copies and as more aquarists since then have joined us in the mailing of eggs and keeping of killies, possibly more information of the peat as a whole might be of interest. Recently I made a small article on Peat for Dansk Akvarieblad as an opening of a series of articles on this particular question in the common aquarium keeping and in particular for aquarists who want to establish a so-called rainforest aquarium.

Peat and Peat moss is a mass formed by more or less decomposed and stabilized remains from sphagnum mosses and/or other mosses and bog-vegetation. In this way nature stores rather many valuable nutritious matters which soon or mostly later might be used by plants. Peat contains many plant nutrients which in the free form are only present in limited amounts in nature, such as carbon (C), nitrogen (N), phosphor (P), sulphur (S), and potassium (K) and also the unlimited nutrients hydrogen (H) and oxygen (O). Normally peat has 55-56% carbon, 33% oxygen, and 3-6% nitrogen. Iron (Fe), calcium (Ca), and magnesium (Mg) are found in the peat also. Peat normally also might contain lots of trace elements once taken up by the living plants or later by the peat itself such as silver, gold, beryllium, zinc, cadmium, scandium, thallium, germanium, tin, lead, arsen, manganese, cobalt, and nickel. The contents of metallic elements vary greatly depending on the conditions under which the peat has been formed and the later contact with the surrounding waters.

Peat and peat moss in nature contain some antibiotics such as penicillin, streptomycin, aureomycin, and alike and the rather strong bacteria killing (or inhibiting) power which is ascribed to peat and bog waters might come from such antibiotics. After all to my opinion the anti bacterial power very often increases during the use of a certain peat sample as bottom layer in tanks (in 1950 I set up my first rainwater tank, since then more and more of my tanks were changed into this type and since 1954 all 40-60 tanks are of this type (except one pit-coal tank in use since 1954). This might lead to the conclusion that certain antibiotics producing organisms establish themselves in the bottom layer and are sending antibiotics out into the water. To my opinion also the brown colour of the aquarium water has only minor influence on the bacteria inhibiting power, but also that something points in the direction that the bacteria inhibiting power is removed together with the brown colour if you use active charcoal in filters for removing of the brown colour of the water. Also some hormones are present in the natural peat and possibly certain sexual hormones present in the peat (oestrogenes etc.) might be of great importance in the breeding of certain rainforest fishes such as Nannostomus trifasciatus, Carnegiella strigata, Acanthophthalmus kuhli etc. Did you ever read the interesting articles of Professor Stolck in the Dutch aquarium magazine "Het Aquarium"? Stolck added urine from pregnant women to the water of the tank in which he had pairs of very difficult rainforest fishes (0.5 ccm per liter) and after some time the females were ripe and he had good spawnings when he removed the breeding pair to urine free waters. No doubt certain sexual hormones are formed during the decomposition of leaves etc. on the dry ground before the rainy season and these are washed out from the decomposing vegetable matters by the rain and force the female fish to produce eggs just at the right time for breeding. Good breeding results in rainforest tanks might in some way be brought about by some hormones in the peat.

Vitamines are also present in peat. A, B, D, F, K, etc. I do not know if they play any role in connection

with the aquarium keeping. Just like active charcoal, peat will willingly take up certain high molecular compounds by absorption. Most of the dyes commonly used against diseases in fish, such as trypaflavine, acriflavine, euflavine, rivanol (all are acridin compounds) and also gentianviolet and methyleneblue are absorbed very quickly, making the treatment of many common diseases in fish very difficult or impossible in rainforest tanks. No doubt also quinine is taken up in just the same way. All these dyes are nominal "kations" as they are "chlorides", "sulphates" or "lactates". No doubt some of the waste products from the fishes are taken up and stay fixed to the peat for some length of time before they decompose into more simple compounds which cannot be fixed by the peat.

Peat has a more or less pronounced power of exchanging ions. The cation exchanging power reminds of the so-called "weak cation exchanging resins" which might be buffered to a certain value of pH. Peat that in nature is not in contact with natural surface waters seems to be charged with many hydrogen ions and therefore will make the aquarium water very acetic indeed, whereas peat (like the common Danish form) which in nature has been in contact with the surface waters (alkaline) a long time ago has exchanged the hydrogen ions for higher metallic ions and therefore such peat will not change the pH of the aquarium water. "Discharged" peat might be "regenerated" in the way we use for cation exchanging resins. The cation exchanging capacity is rather limited compared with the resins. The anion exchanging power is present, but not very well known.

Peat does not take up any copper which comes into the water and the taking up takes place very quickly. This might be taken into consideration when you for example use copper against hydra or oodinium (velvet). The taking up of this cation no doubt takes place in some ion exchanging action (Cu normally has two positive charges). In this way peat will protect against most poisonous metals which come into the water for example from corrosion of the stainless steel or other metal in contact with the water. This taking up of the heavy metallic ions is limited however and if in such tanks the water later on is made more acetic probably poisonous ions might enter into solution. Therefore perhaps such peat should be taken out of the tank and given a "regeneration" using some strong mineralic acid (10% hydrochloric acid HCl).

Peat in contact with water very soon will give away some brown colour which will make the water more and more brownish. If you add peat to 3 samples of water: first using distilled water, second using common hard tap water and third using distilled water added soda, you will find that after a certain time the first one will be less coloured than the second and the second one less coloured than third one. The brown colour comes from certain humates in which metallic ions play a certain role. Humates from calcium and magnesium (Ca^{2+} and Mg^{2+}) are less soluble than humates from potassium and sodium (K^{+} and Na^{+}). Also the pH of the water (or the presence of salts from carbonic acid) play a certain role in the way that alkaline waters will be coloured much more than acetic waters. Once I used to boil samples of peat with a rather strong solution of soda ($Na_2CO_3 \times 10\ H_2O$) and by that way I got a solution which was as brown as a good coffee. This solution was used by aquarists and dealers who added the black liquid to their tanks and claimed to have good results in common "sand-tap water-tanks". A sample of peat treated like this will after some washing to remove the soda give less colouring when used in a tank as bottom layer. The brown colour of the water in the rainforest tank is very stable and not easily removed. If you have a good supply on distilled or de-mineralized water perhaps the best way will be to change the water if it gets too brown. You might use a filter filled with activated charcoal, but do

control the outflow when starting the filter. If the pH of the outflow is too high (often above 8..2!!) you will have to wash the charcoal (we use the common alkaline tap water for these washings and have the tap water very slowly running through the filter for about 24 hours). Charcoal takes up the brown colour rather slowly, but after some days of filtering you will realize good results and all colour might be removed using this material. Such filters on the other hand have very high capacities indeed. I also tried the "Decolourite", a particularly weak anion exchanging resin made by the Permutit Co. which might be regenerated using a weak solution of soda in water. However I did not find this material superior to the common activated charcoal, but it is still in use in a column placed after the outflow of a weak cation exchange resin (Amberlite IRC 50) where it is used to remove any colour (and high molecular compound) present in "old aquarium water" which is treated because of too high pH values. Decolourite has a particularly high capacity when the water is acetic. Many years ago I also used activated aluminum oxide (the gamma modification commonly used for chromatography) to take up the brown colour. This material I regenerated using hot hydrogen peroxide (H2O2) but also this material (very expensive too and not easily supplied) is not superior to charcoal.

Aquarists normally will not permit the water in their tanks to become too brown because this colour to a very high degree steals away the light and plants will suffer. Also the brown colour will decrease the green and blue colours of the fish, whereas in a pleasant way it sets off the yellow-orange-red colours of the fish. And after all as the brown colour possibly does not play any important role in the rainforest tank, why not take it away.

Nothobranchius "melanospilus"

Henry Hansen's stock (or Scheidnass' stock). The original "melanospilus" was described in 1896 by Pfeffer in Hamburg who also described the "guntheri" (in 1893). "melanospilus" came from "Longo Bay" somewhere in Tanganyika. In 1935, in a paper Ahl claims that the "melanospilus" had been confused with another species of Nothobranchius which came from the islands of Saychelles. This island species he called "seychellensis" however. The story of our present stock called "melanospilus" begins with Henry Hansen's voyage to East Africa. He landed in Dar-es-Salam in 1955 and had help form the aquarist Gerry Rowe living at that place. Rowe advised him where to collect specimens of Nothobranchius and perhaps we might say that the stock lived not very far from Dar-es-Salam. In an article Rowe once wrote that he found Nothobranchius in pools and water courses which only had water during some parts of the year. Bottom was clay. The yearly rainfall at Dar-es-Salam ("The Climates of the Continents") is 1180 mm, somewhat differing from one year to another. Most rain comes in April which has a mean rainfall of 300 mm and the dry season falls in June-July-Aug. with about 27 mm each month. The mean temperature is 25.5_C (in the air) and the mean temperature reaches the maximum in Feb. (28_C) and the minimum in July-Aug.-Sep. (24_C). The dry season may last from May to Oct. giving very dry weather and wind blows out from East or Southeast under an almost cloudless sky. The ground dries out and trees loose their leaves.

Hansen brought back his fish to the USA, but by some reason (a strike?) it did not call at New York. So Hansen had to get rid of most of his fish in Philadelphia where they were sold to a local dealer where Jack Scheidnass casually dropped in and had some specimens. Jack did not raise a stock from these fish but he had a few fry which turned out to be males. Later on Jack had another supply of this stock from

Henry Hansen who lives in Florida and from these he formed the present stock which was spread as dry eggs to Germany, Denmark, and Hobkong. Until 1958 this stock mostly was named "guntheri" because Rowe placed that name on the native stock, but later on Rowe informed Scheidnass that he had specimens from the native stock identified as "melanospilus"!!

"Melanospilus" (Hansen's) is a medium sized Notho. which possibly might grow up to 7 cm (however my specimens only reached about 6 cm) and also a somewhat robust species compared with "guntheri" (Griem's) and "palmquisti" (Tropicarium's). In the general look it reminds mostly of "orthonotus" (Griem's or Roloff's). The colour pattern on the body is very near that of "palmquisti" by the way that the fine red lines on the edges of the scales form a very regular net all over the body. Sides are greenish blue and very brilliant. However, this Notho in particular to a much higher degree than the others I know does change its colours and also the metallic cast rather much. It seems as if only males which breed take on the typical colours of a Notho. Other males are very pale and rather colourless. Franz Werner wrote me recently that he also found that peculiarity of "melanospilus". The dorsal and anal fins have much red colour and little yellow if any. Towards the edges the colour changes into blackish or brownish, but the edge itself mostly is distinct shape and jagged in a way not far from the Aphyosemion coeruleum. Caudal fin has a deep red colour which sometimes looks as little brownish. The edge is broadly black. The female is greyish brown as most other known females of this genus, but she has several rather big blackish dots on the hindmost part of her body and even on the root of the caudal fin. These dots sometimes concentrate near the central line of the sides. No doubt this species comes closest to the "orthonotus" ("kuhntae") but at least the males are different in way that we might distinguish clearly between them if we only once have seen them together. This species has no spots (or few) on the lower part of the head. The form breeds true.

Just as other Nothos also this form might give you a lot of trouble in particular when the fish start to mature at an age of about 4-8 weeks. Then very quickly many of them die without any warning, or they catch lots of Oodinium changing the red lines on the foremost part of the body (scale edges) into a whitish yellowish colour, in particular on the head. Well, I use my copper net against this disease and fish recover normally. Indeed the copper is not at all natural in the aquarium keeping. But better keep a live fish under some unnatural conditions than a dead one in a "natural tank". After all if the fish get through the severe crisis of maturity they seem to be rather hard fish. At least my first pair reached an age of 11 months before they died, both within a few days. In the common keeping and breeding procedure this form does not differ from the other Nothos we keep just now.

My stock came in from Jack Scheidnass. On 30 May 58 in a small "pill box" (Dr. Meder's pill box) with 9 eggs in dry peat. Eggs hatched the same day in rainwater and gave totally 8 sound fry which grew up as 7 males and 1 female. On 17 July 58 I washed out the first eggs (few). On 26 July 58 embryo was seen in some of the eggs in glass on shallow water. 03 Aug. 58 big embryo with circulation of blood was seen in some eggs. Dried in moist peat. 02 Sep. 58 first watering gave many fry. That is about 3 months between first and second generation.

Further data of this batch given before. Further spawning until 17 Aug. 58:, then female used in crossings until 07 Sep. 58 (with male "guntheri" (Griem's stock) and male "palmquisti" (Tropicarium stock)).

08-28 Sep. 58: last spawning (in my fishroom). Eggs concentrated and on low water until 12 Oct. 58. And then dried up in peat. First watering on 28 Feb. 59, 01 Mar. 59: lifted out 3 sound fry and 2 belly sliders. Sample washed, found one transparent egg. As in the other species storing (of ripe eggs or eggs which did start the development before drying) for about 4 1/2 to 6 months will kill most embryos or better say resting fry inside eggs under the conditions under which I stored eggs (23-26_C).

24 Mar. 59: "red tail" in one of the fry. 20 mm long. 29 Mar. 59: 2 males and 1 female. All died medium May 59 from Oodinium etc. But they gave some eggs. Spawning until 13 May 59: 62 eggs washed out of peat. According to the surface structure all are from "melanospilus", but egg size varies. 30 May 59: 41 eggs left on shallow water: 2 plus 1 egg without embryo, 26 plus 5 eggs with small and transparent embryo (no blood), 2 plus 5 eggs with bigger embryo with some pigmentation and blood (first number: big eggs; second number: small eggs). 11 June 59: 6 eggs have big (ripe?) embryo, 32 eggs have small, transparent embryo, 1 egg has no embryo (yolk deformed, decomposing?). 20 June 59: 13 ripe eggs dried up in peat. 06 July 59: 21 eggs nearly ripe and 4 still have small and transparent embryo. That will say that after less than 2 months about 90% of the eggs kept on shallow water with free entrance of air are more or less ready to hatch.

Resting Egg in Aphyosemion "filamentosum" Within the bottom spawning Aphyosemion resting eggs are easily produced if one does not wash out the eggs from the fine bottom mud. However, if eggs are washed out and kept in shallow water with free entrance of air, I never saw a resting egg indeed. Also I had little doubt that resting eggs might occur in dry sample of peat. However, I had to revise my ideas on that point: several pairs of Aphyosemion filamentosum were spawning in a 15 liter tank until 23 Nov. 58. Bottom peat was then taken out, fine particles washed out and the loose and coarse peat with lots of eggs was stored in a 200 ccm glass.

05 May 58: egg and peat had first watering: peat washed at once in order to find out the state of eggs. 7 eggs were ripe (some hatched during washing and sorting), 1 egg had nearly ripe embryo, 3 eggs had small embryo with blood and little pigmentation. 4 eggs had very small transparent embryo with no blood and no pigmentation.

The eggs which were not fully developed did develop on shallow water during the following 3 weeks. Indeed they were not dead. The storing peat was not at all very dry, that will say "little more moist than smoking tobacco". No doubt these few eggs (15 totally) where the sad remainders of possibly hundreds by hundreds of sound eggs which did develop during Dec. 58 but had to languish because the watering came too late. The few fry which hatched were rather thin, but livable.

Nothobranchius "palmquisti" (Tropicarium stock) The present stock of a Notho which mostly is called by the species name of "palmquisti" was imported in 1957 by Tropicarium in Munchen. A black-white photo (not very instructive) was shown in one of the last 1957 issues of DATZ. 3 friends and I imported 6 pairs from Tropicarium in early 1958. They came in on 13 Jan. 58 and possibly were aquarium bred youngsters. Very uniform and no doubt a pure stock. I had one pair which was put into a 15 liter tank with very fine mud bottom and the common "rainforest water" to which in this particular case I added 1000 ppm of common salt (1 gramm/liter of NaCl) because fishes came in a water which contained an equal amount of salt. The breeding pair was not fully grown. 20-25 mm in total length.

The real palmquisti was described by Loennberg in "Yngve Sjoestedts Zoologische Kilimandjaro-Meru Expedition 1905-1906. about 5. Vol I" as Fundulus palmquisti. Loennberg had 28 mostly small specimens at hand. These were caught in an inundated cocoa plantation at Tanga on 5 June 1905. He described the colours of the male like this: "Every scale of the male has near its posterior margin a carmine red band and these bands are connected with each other so as to form continuous transversal somewhat wavy red bands across the body in similar numbers as the transverse series of scales... Caudal fin bright red, anal and dorsal fins with carmine red spots in the shape of short streaks on the rays a little weaker on the web but connected into irregular bands across the fins. Female uniformly coloured, probably greenish in life without markings. Largest male measured from tip of snout to end of caudal fin 42 mm. Nearly related to F. guntheri Pfeffer...2" Our present stock might be identical with Loennberg's species.

From an aquarists point of view this species or race is closely related to our present stock of "guntheri" compared with the other species which we keep at present in tanks. "palmquisti" is smaller than "guntheri". Males rarely grow bigger than 50 mm total length and females in particular are much smaller than females in "guntheri". Most of the about 25-30 females I raised did not exceed 40 mm at an age of about 6 months. This summer I had one female "palmquisti" and one female "guntheri", same age, growing in the same small tank together with some male "palmquisti". Female guntheri grew faster and now after about 4 months she is at least 50% bigger than female palmquisti. She is also bigger than the male palmquisti of same age which have been together with her since hatching.

The male "palmquisti" no doubt is the most handsome of the Nothos presently kept in tanks. Possibly one of the most handsome aquarium fish ever kept in tanks. The ground colour of the male is brilliant blue in the head and the sides of the body, against the back this colour diffuses into a greenish olive, whereas against the belly and throat the blue colour diffuses into a clear yellow colour (lemon). The eye is big and has a glaring blue cast. Every scale on the body sides is finely edged by a clear red line, these lines forming a very regular net pattern on the body sides, just as in the "melanospilus" of Hansen's stock. Dorsal and anal fins are very big (compared with "melanospilus" of Hansen) and have a beautiful clean lemon ground colour, dotted with red. Caudal fin might be brilliant uniformly red and no dark edge is seen on the hindmost part of that fin (my friend Claus Petersen lost his pair in 1958 and cross bred some of my males with some of his females "guntheri" and had some fry which were just like my males "palmquisti" but the caudal fins in these possible hybrids had a sharp blackish edge, just as in the "pure guntheri". Dr. Ladiges informed me that male in the German stocks of "palmquisti" might have a dark edge of the caudal fin.

Dr. Ladiges also found that these stocks showed an abnormal dispersal in the zoological measurements. This points in the direction of a conscious or unconscious crossing between the pure stocks of "palmquisti" and "guntheri". Also as "palmquisti" uses to give up to 90% of males in the broods and "guntheri" uses to give a great surplus of females there might be a temptation in cross breeding these two forms. As mentioned on page 72 also the crossing of the "palmquisti" male to the "guntheri" female is very easy. Therefore it might be of importance that some of us try to keep the pure stocks of both forms.

The females of both "palmquisti" and "guntheri" have no dark spots on the body sides, nor on the fins.

Therefore they are easily distinguished from the females in "melanospilus" (Hansen's), the "kuhntae" (Griem's or Roloff's), the "mayeri" and "orthonotus" (Roloff's) because in these forms the female has the dark spots on the body (and fins?). As also "rachovi" (Roloff's stock) now is going to be spread among the egg receivers we have to face another problem because the female "rachovi" is very, very close to female "palmquisti". I think I will always be able to take any female "palmquisti" out from a mixed brood of "palmquisti" and "guntheri". It is not easily explained how to do this because it mostly is a question of knowing these two forms very well. The first step might be looking at the colours. "guntheri" is more brownish, "palmquisti" is more olive and more transparent. Her anal fin might be longer than in "guntheri". But after all most differences you will find in the general look. Possibly I will not be able to distinguish between females "rachovi" and females "palmquisti" just now. Female "rachovi" seems to have some green colour in her anal fin when she is seen in a certain light. My stock of "palmquisti" bred true in 1958 and I hope to keep the pure form as in 1959, but as females are so rarely developed in this form I might miss the pure stock. Therefore if you still have the pure stock, please try to keep it.

Tanga is situated at the coast of Tanganyika near the frontier to Kenya. This place falls within the proposed distribution of "guntheri". The keeping of this species in no way differs from the other forms presently kept in tanks. The "weak point" is the period of maturity where at least the males are very sensitive against diseases and lots of them might die within a few days. After maturity the form is much more robust and my big breeding stock in 1958 did not give any severe problems for many months. It seems as if the cleanness of the water plays a certain role, also that problems appear together with the blue green algae, but this does not hold true in all cases. My copper net possibly saved my last remainders of the pure stock this year. Whenever any trace of Oodinium (whitish or yellowish edges on scales in particular on head and neck) appear, the copper net is placed in the tank . In 1958-59 I kept lots of males together in small tanks (25 or more in 15 liter glass tanks) and rarely they did hurt each other. Breeding took place in the same tanks with 3-4 males and about 10 females in each tank. Even in these tanks the males normally did not hurt each other. Recently I was looking into my big 320 liter tank where lots of Cynolebias melanotaenia live (mostly males) a few big males "palmquisti" ("weeds") came out from the broods of "melanotaenia". One of these males was severely fighting a smaller male of "melanotaenia". I was surprised to see how close these two non-related species certainly were in the fighting procedure and how red the caudal fin of the "melanotaenia" appeared compared with the deep red of the "palmquisti". Even as the "melanotaenia" was smaller than the "palmquisti" I did not doubt that he would win that battle. Also if you place some females "ladigesi" in a tank together with some female "palmquisti" (small) most aquarists would be in great trouble to distinguish between these two sorts of females.

Also in the breeding procedure there seem to be no particular differences between the stocks of Nothos now kept in tanks. Spawning takes place chiefly on the upper layer of the mud, but as males press the females side wards and downwards she may disappear into the mud and by this sideward downward pressing of the male the small "holes" in the mud are formed. The male uses his big dorsal and anal fins to keep the female firmly at the right position during spawning. Eggs are plentiful, but they are small. Most measure about 1.0 mm and they are not circular. Membrane is provided with short and rather stiff "hairs" standing right out from the surface at least when eggs are kept in water. They are exactly as eggs from "guntheri" and "rachovi", maybe there is little differences in the concentration of hairs on

membrane, but possibly not enough to make it possible to distinguish between eggs from these 3 forms. Eggs do not adhere to peat, normally.

My females produced about 100 eggs each week (30 mm females) but no doubt they are able to spawn any more eggs in a week.

Egg Data: Old pair:

- 13 Jan.-04 Feb. 58 washed out 172 eggs. All were placed in a cup on shallow water in order to find out the way of development.
- 19 Feb. 58 (after 15 days): many eggs have embryo with pigmented eye.
- 27 Feb. 58: first fry hatched (water had 1000 ppm of NaCl) (at least) without my help, it is a belly slider.
- 13-15 Mar. 58: take out 70 eggs and try hatching using dry food in the normal way. All did hatch. Only 7 were not belly sliders and gave my 7 fine males.
- 01 Apr. 58: dry food on 8 ripe eggs gave 3 sound fry from which the first female appeared. She was raised together with one of her brothers in a 15 liter glass tank, plenty of room and plenty of food.
- She was growing at the same speed as the male and 13 May 58 I washed out more than 100 eggs from their tank, but most got fungus (normally one gets very few infertile eggs from this species, but this male was very young indeed).

Old pair:

- 04-25 Feb. 58 very many eggs seen. These concentrated with little coarse peat and kept on shallow water until 14 Mar. 58, then dried quickly and very hard. Samples were mailed to Scheidnass (45 fry), Emmens (1 fry) and Agar (0 fry). Professor Emmens saw many "eyed eggs" in the peat which possibly was frozen in airplane. After packing these 3 batches a small sample of fine dry peat was left. I saw a few eggs. I put that sample (1/2 a pipe full) into rainwater and next day I had 119 fry (05 May 58).
- On 20 May 58 (after 16 days) the first male showed his red tail.
- On 27 May 58 (after 23 days) I noticed the first spawning. As none of the other 5 pairs imported did give any results I had to distribute this brood on 5 different tanks (15-25 liters) in order to establish a stock. Indeed this was a good idea because soon after the sorting 30 fine specimens in one of the tanks died within 24 hours without any warning, no young "palmquisti" in this tank did survive. Also in some of the other tanks young "palmquisti" began to die, but not all were killed.

Fry is rather small and not very pigmented. They measured about 4.0 mm just after hatching, but after 14 days they normally measured 15 mm.

Old pair:

- 25 Feb.-14 Mar. 58: very many eggs. After washing out of fine particles the sample was dried at once.
- 04 Apr. 58: first watering, no fry, all eggs inspected were transparent and had no trace of an embryo. Under the microscope I saw fine strings in eggs (resting embryo?). Dried at once.
- Second watering 20 Apr. 58: no fry, eggs are not apparently changed. Dry again on 22 Apr. 58.
- Third watering on 17 May 58. 25 fry the residue dried and mailed (Emmens and Guevara).

Old pair:

- 14-19 Mar. 58 76 eggs washed out of mud. Mixed up in moist peat and dried very hard at once.
- 03 May 58: several eggs were "shaken" out from the dry peat (very dry peat). All are transparent, no trace of a developing embryo.
- 08 May 58: first watering, no fry. Peat stayed in water until 18 May 58, then some eggs were washed out for inspection. Now the embryo is growing and blood systems have developed. Dried up and mailed (Agar) on 19 June 58. As far as I am able to find out from the many spawnings of 1958 in "palmquisti" the development of the eggs might be belated (as resting eggs or more possibly as resting embryo) if you dry up peat at once after removing the bottom mud of the breeding tank. This "rule" might be true for all Nothos. The more you dry up the peat, the more belated eggs you will get. If eggs are kept on shallow water with free entrance of air most of them will develop within the next 3-4 weeks.

In the breeding of annual fish it may be of great importance to know how long a certain sample of eggs in dry peat might be stored at room temperature without killing all fry in eggs. Certainly this question is not easily answered because much depends on how many eggs in the peat will stay in the state of resting egg/resting embryo and how many eggs will develop to a resting fry and last but not least how long will a resting fry be able to survive in this state without being hatched.

Here are some data from peat samples which were kept during the winter 1958/59 hoping to give a fresh stock of "palmquisti" in the early spring of 1959. All these samples were strongly concentrated and had hundreds by hundreds if not thousands of eggs.

1) spawning 19 females 12 July-02 Aug. 58: eggs on shallow water until 23 Aug. 58 and then dried up in little peat. 28 Feb. 59: first watering gave 5 sound fry, 5 belly sliders plus 33 eggs with fully developed fry, rather turbid to look at, but alive, 2 transparent eggs resting eggs. A few fry hatched from the 33 ripe eggs, all other fry soon died inside the eggs. 2 transparent and good eggs developed on shallow water.

2) spawning until 04 Oct. 58: sample dried on 10 Oct. First watering on 20 Apr. 59 very many "grey" eggs (with ripe fry, dead) were seen on the bottom of the jar and at the surface of the water. Only 25 fry were alive on 22 Apr. 59. They are very weak. Among the many dead eggs I found 11 transparent resting eggs which developed later on in water.

3) Klementsens "exchanged female" spawning one of my females until 11 Oct. 58. 11 eggs. Low water until 22 Nov. 58, then all more or less ripe. Dried 22 Nov. 58. 28 Feb. 59: hatched 5 sound fry plus one belly slider plus one sound fry after another 36 hours, no eggs in peat. All these (4 survived) fry turned out to be males (see "sex ratio").

4) last spawning until 20 Nov. 58, dried at once. Half of this sample was watered on 07 May 59 and gave 18 more or less sound fry, 1 ripe egg, 1 egg with half developed embryo and 1 resting egg. Other half was watered on 22 June 59 giving 14 fry, some of these are very weak. Only one egg was found in peat: a fine resting egg. No eggs with dead fry seen in this sample. All samples were stored at 23-26_C in my fishroom.

These results indeed are not very encouraging compared with for example Cynolebias and Cynopoecilus, the Pterolebias peruensis not to be mentioned. No doubt we have to find out a method to prevent the

transparent eggs to develop and then why not try the closed and water filled ampoulle or to keep eggs under fine mud under water.