Natural History Note

Survival strategies of sharptooth catfish *Clarias gariepinus* in desiccating pans in the northern Kruger National Park

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Observations in drying out pans showed that small (26–37 cm) sharptooth catfish (*Clarias gariepinus*) can hide at the bottom of small pools filled with sticky mud whereas larger fish stay afloat at the surface in larger pools with sloppy mud, where they easily become prey or succumb to heat stress. The inability of larger fish to keep down in the sloppy mud of up to 40 cm depth is the result of their large bulk and high density of the mud. This may indicate a survival advantage for smaller fish in the final dry-out phase of pools and is supported by the presence of only small fish remains in the last drying up pools of dry pans. Another adaptation of smaller fish includes the temporary congregation outside the water enabling concealment under dense vegetation as a means to escape adverse environmental conditions, including high water temperatures and avian predation. The advantage small fish have over larger catfish under these extreme conditions may explain why catfish are known to show a wide variation in growth rate under natural and aquaculture conditions.

Key words: catfish, *Clarias gariepinus*, desiccation, survival strategies

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Introduction

The sharptooth catfish (*Clarias gariepinus*) is well known for its hardiness and wide distribution range stretching across the equator into temperate zones in both hemispheres in Africa (Bruton 1979a; Skelton 1993). It is not only found in all permanent waters of its distribution range, but is also one of the pioneer fish species inhabiting semipermanent and even completely seasonal waters. The regular appearance of catfishes in such temporary waters has led to the erroneous belief that it may survive under the dried up mud of pools and pans (Stevenson-Hamilton 1947; Greenwood 1958; Crass 1964; Bruton 1979b). There is however the possibility that this fish and even some other species including tilapia (*Oreochromis* spp.) may under special conditions, survive underground in sandy rivers that maintain underground water flow (Donnelly 1978; Van der Waal 1997a). In muddy environments however, this fish seems not to be able to excavate tunnels downwards in drying out mud (Bruton 1979b). It can not survive under the surface of dried up mud of swamps and pools as the African lungfish (*Protopterus annectens brieni*) can (Donnelly 1973; Bruton 1979b). The last mentioned fish possesses a real lung, is able to dig its own tunnel and chamber in the mud and to rise regularly to the surface to inhale air until the mud dries up around it. It then survives aestivating in a cocoon under the dried mud until the next rainy season (Bell-Cross & Minshull 1988). Donnelly (1973) described how catfish survived in the thick mud by aerial respiration but when the mud started to form a crust, the catfish could not dig into the mud and died as result of predation, heat and desiccation.

Bruton (1979b) also did not find any proof of catfish surviving in or under dried out mud but reports the ability of catfish to enlarge existing burrows at the edge of shallow pools or even dig their own burrow underneath tree roots.

Fact is that with the exception of the lungfish, the sharptooth catfish can survive in moist or even hardening mud for a longer time than any other fish species. This alone can be of tremendous survival value in semiarid regions where many seasonal water bodies start drying out just at the beginning of the rainy season.

The Pafuri (Makuleke) region in the Kruger National Park is such an area. The survival of catfish in semipermanent pans of the Limpopo River could be followed during a research programme on these pans. Some adaptations to increase the survival of this fish when water levels are low and environmental conditions become critical, are reported on in this note.

Materials and methods

Six floodplain pans of the Limpopo River and two pans connected during floods to the Levuvhu River in the northern Pafuri region of the Kruger National Park were monitored for fish life on a seasonal basis from 1993 to 1996. It was not always possible to visit these pans specifically to determine the fate of the fish trapped in drying out pans. However, pans that had contained catfish, and subsequently dried out during the dry season and thereafter filled with rain water after a period of complete dryness, offered the opportunity to determine catfish survival in pans with a muddy bottom.

Quarterly collections were conducted using a gillnet with eight 10 m long panels of 18–150 mm stretched meshes as well as five separate gillnets with 25–180 mm meshes. In smaller pans or where a pool with a depth of less than 80 cm remained, a 17 m bagged seine (10 mm mesh) was employed to collect a sample of the fish population. Where mud was all that was left, a search was made for survivors using the seine and dipnets. In completely dried out pans, physical inspection of the deepest parts were made for any signs of life or remains of fish. Maximum depth of pans was determined with a calibrated pole.

All fish collected were measured (total or fork length, cm), their ripeness determined (externally by pressure on the abdomen) and released. Large hauls were made in drying up pools where all fish could be collected. As it was impractical to count and measure all fish collected, subsamples of one dipnet full were counted and measured and the total estimated on the basis of number of dipnets filled.

Results

Survival of catfish in dry pans

The presence of catfish and some other hardy fish species found in six drying out pans, is listed in Table 1. Three pans that contained fish including *C. gariepinus* as the last surviving species, dried up for a few months and afterwards filled up with rain water from their own restricted catchments. No fish were collected in any of these pans during the following summer season. Catfish were not able to survive in dry pans with muddy substrates.

Data from Rietbok and Makwadzi Pans show how the fish diversity in pans decreases as water levels drop and environmental conditions deteriorate until only catfish remain.

Survival of catfish in shrinking pools

Although catfish invariably were the last fish species to disappear from the pans, serious mortalities seem to occur long before a critical stage of desiccation is reached. Rietbok Pan was populated by more than 10 000 catfish in June, mostly small young-of-the-year fish. By September almost all these fish had disappeared and only 22 larger fish could be collected (Fig. 1). This high mortality is ascribed to heavy predation in this pan, mainly by larger catfish and also piscivorous birds. In other pans similar low numbers of catfish were collected once the mud started to become sloppy.

Table 1
Fate of fish in drying up pans in the Pafuri area of the KNP

Pan	Date	Pan condition	Max. depth	Fish species cm	Fish length Total or fork length, cm	Numbers collected
Makwadzi	22-06-94	half full	100	*Labeo rosae*	26-28	4
				L. congoro	31	1
				Barbus afrohamiltoni	10	1
				Oreochromis mossambicus	1-24	28
				Clarias gariepinus	35-37	2
	06-09-94	large pool	75	*Clarias gariepinus*	21-50	124
	07-12-94	dried out	0	*Clarias gariepinus* skull length	5,0-9,5	500+
	25-02-95	full (rain water)	160	no fish		
	10-04-95	full	140	no fish		
Rietbok	28-06-93	large muddy pool	60	*Clarias gariepinus*	16-87	10000+
				Oreochromis mossambicus	2-24	14
				Cyprinus carpio	43	1
	09-09-93	small muddy pool	25	*Clarias gariepinus*	19-86	22
	11-12-93	small pool (rain water)	50	none		
Nyavadu	08-09-93	shrinking pool	70	*Clarias gariepinus*	14-48	307
				Oreochromis mossambicus	1-23	96
				Barbus afrohamiltoni	7-9	2
	11-12-93	quarter full (rain water)	100	*Clarias gariepinus*	29-35	8
Hapi	21-06-94	pool	50	*Clarias gariepinus*	16-66	19
	06-09-94	drying up	1	none		
	06-12-94	half (rain water)	230	none		
	26-02-95	full (rain water)	250	none		
Manxeba	22-06-94	pool	55	*Clarias gariepinus*	13-32	24
				Oreochromis mossambicus	1-15	43
	06-09-94	mud pool	50	*Clarias gariepinus*	17-47	10
	06-12-94	dried up	0	no fish		
	25-02-95	pool (rainwater)	60	no fish		
	10-04-95	pool	50	no fish		
Vhembe Bend	07-12-94	small mud pool	50	*Clarias gariepinus*	26-37	14
	07-12-94	large pool	50	*Clarias gariepinus*	29-92	21
	26-2-95	full (rain water)	200	*Clarias gariepinus*	8-13	4

Fish behaviour in the shrinking mud pools

As result of their constant thrashing and rubbing movements on the bottom before the water becomes a sloppy porridge, the catfish actually harden and deepen a central area of about 40–50 cm deep in the shrinking pool in which they hide. This was noted in Rietbok Pan on 9 September 1993 and Manxeba on 6 September 1994. In Rietbok Pan a central area of 7 m x 8 m had been deepened to 40 cm by the fish, surrounded by an area of

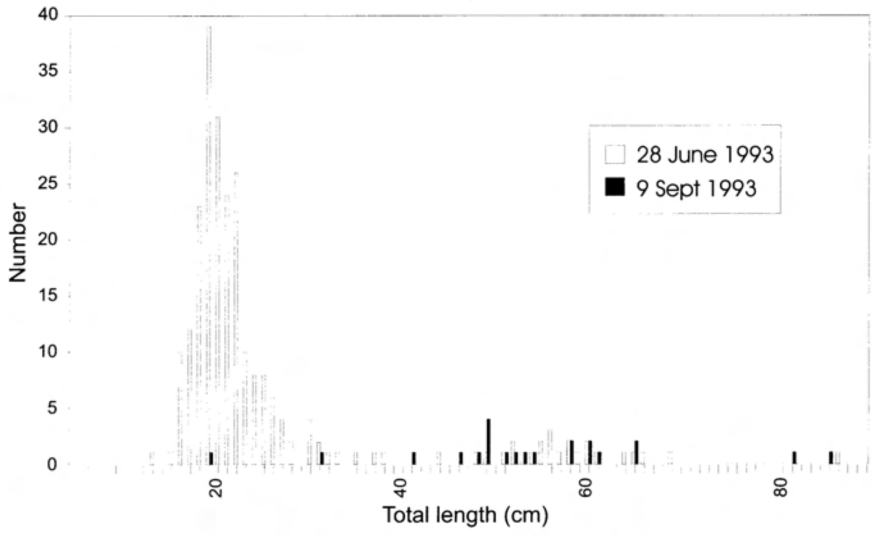

Fig. 1. Length frequencies of catfish populations sampled in Rietbok Pan on 28 June and 9 September 1993.

more than 15 m x 20 m of only 2–8 cm deep. In Manxeba Pan a deeper area of 2 m x 1.5 m and 50 cm deep had been created in the centre of a 7 m x 5 m pool. Evidence of a smaller area kept deeper by the constant movement of the fish was also evident in the dry Makwadzi Pan where skulls and remnants of smaller catfish were only found in a pronounced depression in the deepest part of the dried out pan (Fig. 2).

Fig. 2. Remains of small catfish in the lowest depression of the dried out Makwadzi Pan on 7 December 1994.

As water evaporates, the mud thickens and fish are not able to move around and keep the mud in a liquid form. Then the behaviour of the trapped fish changes and is in agreement with that described by Donnelly (1973) on a drying out oxbow in the Busi River where the fish stayed inactive in the top layer, covered by a film of mud. His illustrations show the backs of those fish sticking out prominently above the mud surface, where they were subject to a daily temperature variation of 13.5–27.5 °C.

Do small fish survive better than large fish?

Vhembe Bend Pan (22°22'32"S, 31°12' 37"E) was visited on 7 December 1994. Only a shallow triangular muddy pool of 15 m x 10 m was left with the backs of a dozen large catfish showing above the mud surface. They were either lying still or suddenly splashing around to breathe, to get deeper under the surface and to replace the warm, drying mud on their backs. When collecting these fish for measuring purposes, the student helpers found the mud to be soft and sloppy to a depth of 45 cm and with an unexpected firm bottom below that. The central portion of the pool was also abruptly deeper than the rest. This deeper pool is thought to have been created by them through their earlier activity. After the catfish had been collected and measured, the two helpers entered the pool to cool themselves. They found that they could easily float on their backs in the mud, their heads, chests, hands and feet protruding above the surface as result of the high density of the sloppy mud (Van der Waal 1997b). This relatively high density of the mud explains the regularly observed backs of catfish protruding above the mud surface (Donnelly 1973, Plate 2 and 3; Van der Waal 1997b) and the resulting inability of especially larger fish to hide themselves in the mud of drying out pools—not as could be expected because the mud pools were so shallow, but because the higher density of the muddy water caused the fish to float on the surface. As result of their large bulk, they were unable to stay submerged.

Fig. 3. Collecting small catfish from the bottom of a small pool in Vhembe Bend Pan.

With exception of two smaller fish, all 19 other fish collected in the main pool had a length between 62 cm and 92 cm (mean total length 74.73 cm ± 9.15 cm). Some movement was observed in two tiny pools of only about 50 cm diameter, spaced 12 m away from the main pool. The mud here was slightly more viscous than that of the larger pool and catfish breathing activity was seen here every minute but no fish were seen on the surface. These fish could not be scooped out with both hands, as was practised in the larger pool, but had to be dug out of the viscous mud in the bottom of the small pool. A total of 14 fish were uncovered from one small pool, all measuring between 26 cm and 37 cm long (mean total length 34.57 cm ± 4.39 cm) (Fig. 3). They were typically collected while they were in a vertical position, with their heads pointing downwards, stuck into the sticky mud. Only at intervals did they come up to breath by turning around and rising to the surface to replace the air in their suprabranchial chambers in the typical way described by Donnelly (1973).

Small catfish leave the water to promote survival chances

On 20 November 1996 a visit was made to Gila Pan (22°24'15"S, 31°16'45"E), a shallow pan overgrown with the coarse *Sporobolus ioclados* grass and sporadically receiving water from the Limpopo floods. During the high floods of February 1996, this pan, like all other pans, was directly connected to the Limpopo River, and could thus be colonised by migrating catfish. By November 1996, only a small pool of 25 m x 10 m and up to 40 cm deep remained. The presence of a concentration of piscivorous birds—1 fish eagle, 1 goliath heron, 4 grey herons, 3 saddlebill storks, 16 marabou storks, 4 wood ibises counted (Fig. 4)—prompted closer investigation. No air breathing by catfish, or any other movement was observed besides two submerging large (4 m) crocodiles. A noise similar to duck feet on moist mud was heard underneath a large clump of dense overhanging *Sporobolus* grass 3 m from the pool. This turned out to

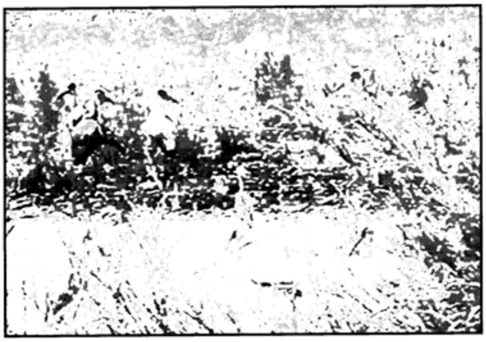

Fig. 4. Drying out pool in centre of Gila Pan surrounded by piscivorous birds.

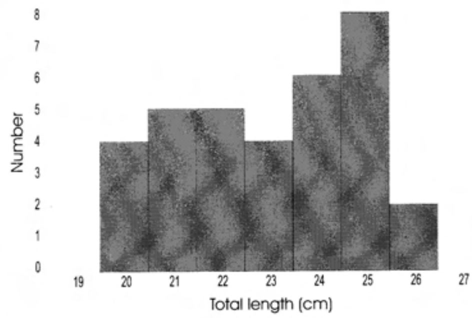

Fig. 5. Length frequency of a sample of 34 catfish from Gila Pan, 20 November 1996.

be the wriggling and air breathing noises of an estimated 10 000 + small catfish (mean total length 23.03 cm ± 1.88 cm (Fig. 5) that had congregated out of the water underneath this relative thick shadowy cover (Fig. 6). When the fish were eventually disturbed, they wriggled down two shallow canals of about 2 m long towards the pool but stayed in one shoal of 3.5 m diam. and crawled underneath a small clump of *Phragmites australis* reeds standing in 5 cm deep water. Here the catfish concentrated again in one tight heap until at least two layers of fish were completely out of the water (Fig. 7). All the time fish from the perimeter wriggled towards the centre and in the process crawled on top of the other fish. For a brief period of not more than 30 seconds all fish would lie absolutely still until one fish started breathing or wriggling again, triggering off a sudden activity of wriggling, breathing and splashing. The fish were observed under the clump of *Sporobolus* for more than 45 minutes and for 30 minutes in shallow water. An hour later most of the small catfish had again crawled out of the pool underneath grass cover at another site next to the pool and were repeating their congregating activity.

Discussion and conclusions

Donnelly (1973) reported that catfish survived in the sloppy mud of a drying out pool in the Busi River, Zimbabwe. When the mud started to form a crust, the catfish were unable to dig into the mud and all eventually died as result of predation and desiccation. Our observations fully support this. The ability to survive longer in desiccating pools than other fish species such as *O. mossambicus* and *C. carpio* is considered to be of great survival value for the sharptooth catfish. In areas where many water bodies start drying out just at the beginning of the rainy season, this fish species often is one of the dominant fish species.

In a pond in northern Namibia catfish were observed swimming in a pond that had received some rainwater just when the mud

Fig. 6. Congregation of small *C. gariepinus* beneath a mat of coarse *Sporobolus* grass on the edge of Gila Pan. Note small channel leading to open water.

Fig. 7. Young catfish re-assembling in one pile in pool of Gila Pan after being disturbed.

had started to form a crust (Van der Waal 1997b).

The presented data support the findings of Donnelly (1973) and Bruton (1979b) that catfish can survive in drying up pools until the mud starts to solidify. Under these conditions, smaller fish appear to have a better chance of survival than larger fish. As result of the inability of larger (> 40 cm TL) specimens to submerge and stay under the surface of the thick mud, they are prone to predation by fish eagles, marabou storks, hyaenas and jackal. Additionally, they could succumb as result of extreme surface temperatures and sunburn. Small catfish managed to escape the dangers of having to lie on the surface by wriggling down into the viscous mud and staying down, head first, in the cooler mud. This behaviour has survival advantages for smaller catfishes under these extreme conditions. The presence of mainly small catfish skulls in the deepest depression of dried up pans, also demonstrates that smaller fish survive longest.

Catfish exhibit widely divergent growth rates, both in natural as well as aquaculture conditions. Minimum lengths to reach maturity in different populations in southern Africa varied between 23 cm and 67 cm (Gaigher 1977; Bruton 1979a; Hamman 1981) and fingerlings from the same batch stocked together in the same fish pond had total lengths of 3–25 cm after 12 weeks of growth (Van der Waal 1978). This inherent variability in growth rate in this fish species presents survival advantages under favourable conditions when faster growing, larger specimens can benefit. Under extreme desiccating conditions however, smaller, slower growing or younger individuals may have a better survival rate. The variable growth rate found in this species is possibly maintained by a lower mortality rate amongst fast growers during normal wetter conditions as well as the survival of smaller or slower growing individuals in the extreme conditions during years of lower than normal rainfall.

The ability of catfish to shoal and prey in unison, has been documented (Donnelly 1966; Merron 1993) and the synchronised aerial breathing described by Donnelly (1973) and Bruton (1979b) indicates a communicating ability amongst members of a shoal. Movement overland to reach another water body has also been recorded (Bruton 1979b) and these fish are able to enlarge existing burrows under tree roots or even construct their own temporary burrows (Bruton 1979b). The shoaling and temporary migration out of available water into the shade and protection of overhanging vegetation, presumably to avoid unfavourable conditions such as high water temperatures and avian predators is further proof of the ability of this fish to adapt and survive under extreme conditions.

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References

BELL-CROSS, G. & J.L. MINSHULL. 1988. *The fishes of Zimbabwe*. Harare: Trustees of the National Museums and Monuments of Zimbabwe.

BRUTON, M.N. 1979a. The breeding biology and early development of *Clarias gariepinus* (Pisces: Clariidae) in Lake Sibaya, South Africa, with a review of breeding in species of the subgenus *Clarias* (*Clarias*). *Transactions of the zoological Society, London* 35: 1–45.

BRUTON, M. N. 1979b. The survival of habitat desiccation by air breathing clariid catfishes. *Environmental Biology of Fishes* 4(3): 273–280.

CRASS, R.S. 1964. *Freshwater fishes of Natal*. Pietermaritzburg: Shuter & Shooter.

DONNELLY, B.G. 1966. Shoaling, communication and social hunting in the catfish *Clarias ngamensis*. *Piscator* 67: 54–55.

DONNELLY, B.G. 1973. Aspects of behaviour in the catfish, *Clarias gariepinus* (Pisces: Clariidae), during habitat desiccation. *Arnoldia* (Rhod.) 6: 1–8.

DONNELLY, B.G. 1978. Evidence of fish survival during habitat desiccation in Rhodesia. *Journal of the Limnological Society of southern Africa.* 4: 75–76.

GAIGHER, I.G. 1977. Reproduction of the catfish (*Clarias gariepinus*) in the Hardap Dam, South West Africa. *Madoqua* 10 (1): 55–59.

GREENWOOD, P.H. 1958. *The fishes of Uganda.* Kampala: Uganda Society.

HAMMAN, K.C.D. 1981. Aspekte van die visbevolkingsdinamika van die Hendrik Verwoerddam met verwysing na die ontwikkeling van 'n visserybestuursplan. PhD thesis, Rand Afrikaans University, Johannesburg.

MERRON, G.S. 1993. Pack-hunting in two species of catfish, *Clarias gariepinus* and *C. ngamensis*, in the Okavango Delta, Botswana. *Journal of Fish Biology* 43: 575–584.

STEVENSON-HAMILTON, J. 1947. *Wildlife in South Africa*. London: Cassell.

VAN DER WAAL, B.C.W. 1978. Some breeding and production experiments with *Clarias gariepinus* (Burchell) in the Transvaal. *South African Journal of Wildlife Research* 8: 13–17.

VAN DER WAAL, B.C.W. 1985. Aspects of the biology of the larger fish species of Lake Liambezi, Caprivi, South West Africa. *Madoqua* 14(2): 101–144.

VAN DER WAAL, B.C.W. 1997a. Some observations on the fish life in a seasonal sand river. *Southern African Journal of Aquatic Sciences* 23(1): 95–102.

VAN DER WAAL, B.C.W. 1997b. Hoe oorleef babers droogtetoestande? *Custos,* November 1997: 23–25.