Onderstepoort J. vet. Res., 56, 215–218 (1989)

RESEARCH COMMUNICATION

SOME OBSERVATIONS ON THE NARCOTIZING ABILITY OF ELECTRIC CURRENTS ON THE COMMON CARP *CYPRINUS CARPIO*

W. T. BARHAM[1], H. J. SCHOONBEE[2] and J. G. J. VISSER[1]

ABSTRACT

BARHAM, W. T., SCHOONBEE, H. J. & VISSER, J. G. J., 1989. Some observations on the narcotizing ability of electric currents on the common carp *Cyprinus carpio*. *Onderstepoort Journal of Veterinary Research*, 56, 215–218 (1989).

Some effects of alternating current electronarcosis and of rectified current electronarcosis on *C. carpio* were investigated. In all instances recovery from narcosis was accompanied by convulsive spasms. Haemorrhaging of the gills was also observed to occur. Carp do not appear to be suitable candidates for electronarcosis.

INTRODUCTION

The European common carp *Cyprinus carpio* is one of the most domesticated freshwater fish used in aquaculture today. Although the pond production of tilapia is still on the increase in countries such as Taiwan and Israel (Schoonbee, personal observation, 1988) the common carp still remains an important table fish in the Mediterranean and northern European countries. Even in Israel where pond production of tilapia has increased significantly from 5 % of the total pond fish yield in 1967 to almost 27 % in 1987 (Sarig, 1987), the common carp still comprises more than 60 % of the total tonnage of pond fish produced. For this reason research on its feeding and reproduction biology is still continuing (Viola & Arieli, 1983; Siwicki & Studnicka, 1986; Viola, Arieli & Zohar, 1988).

C. carpio is known to survive water temperatures well below 10 °C but can also withstand warm water conditions exceeding 30 °C (Schoonbee, personal observation, 1972). It has a tough leathery skin richly endowed with mucus cells and has been subjected to a number of blood physiological studies locally (Ferreira, 1979, 1982; Smit, 1980).

Barham Schoonbee & Visser (1987b, 1988, 1989) reported on the narcotizing effects of electric currents on the tilapia *Oreochromis mossambicus* and came to the conclusion that alternating current was the method of choice for that species. The present study evaluates the use of both alternating and rectified currents on *C. carpio* as possible alternatives to chemical anaesthesia.

MATERIALS AND METHODS

The materials and methods were those used by Barham *et al.* (1987a,b, 1988, 1989). Fish were electronarcotized individually in a 60 cm long 48 ℓ capacity aquarium. Water temperature was 20 °C unless otherwise indicated. Alternating current electronarcosis was induced at a potential of 60 Vrms, except in the voltage trials. Rectified current electronarcosis was induced at a potential of 100 Vp. Each group consisted of 8 fish.

RESULTS

The effects of alternating current electronarcosis

The effects of voltage

Although there was a significant difference (P = 0,01) in mean narcosis times between 15 Vrms and 30 Vrms and highly significant differences (P = 0,001) in the mean narcosis time at 15 Vrms and the mean times obtained at 60 Vrms and at 90 Vrms, the mean narcosis times at 30, 60 and 90 Vrms did not differ significantly from each other (Table 1, Fig. 1). This pattern is reinforced by narcosis coefficients which show clearly that, with a mean narcosis coefficient value of 1,2 s cm^{-1}, a potential of 15 Vrms was the least effective voltage. Furthermore an increase in the potential beyond 30 Vrms did not result in a substantial improvement on 2,1 s cm^{-1}. The higher voltage also resulted in longer opercular recovery times than at the lowest voltage but once again there were no significant differences in these times at the higher voltages. This pattern extended to recovery times.

At all voltages the fish exhibited erratic opercular movements shortly after the current was switched off

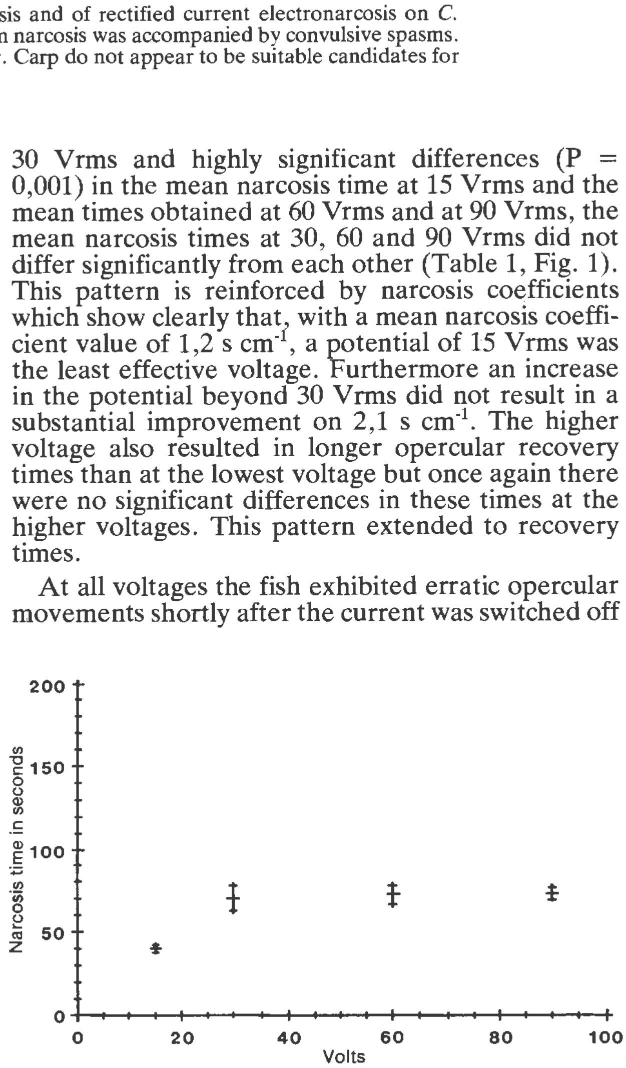

FIG. 1 The effect of alternating current electronarcosis at 3 different potentials on mean narcosis time (± SE)

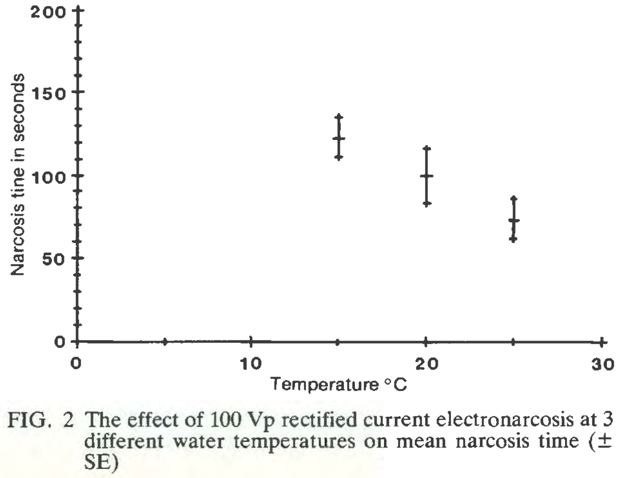

FIG. 2 The effect of 100 Vp rectified current electronarcosis at 3 different water temperatures on mean narcosis time (± SE)

[1] Tilapia Research Unit, University of Zululand, Private Bag X1001, KwaDlangezwa 3886, Republic of South Africa.

[2] Department of Zoology, Rand Afrikaans University, P.O. Box 524, Johannesburg 2000, Republic of South Africa.

Received 6 March 1989—Editor

TABLE 1 The effects of alternating current electronarcosis at 3 different potentials on opercular recovery, narcosis and recovery times respectively

		Length (cm)	Mass (g)	Opercular recovery time (s)	Narcosis time (s)	Recovery time (s)	Narcosis coefficient (s cm^{-1})
15 V	n =	8	8	8	8	8	8
	Minimum	30,7	470,7	31,7	34,8	0,0	1,1
	Maximum	34,3	618,4	43,7	44,2	11,0	1,4
	Range	3,6	147,7	12,0	9,4	11,0	0,3
	Mean	32,5	563,3	37,6	40,1	4,2	1,2
	Standard dev.	1,4	59,7	3,7	3,7	4,3	0,1
	Standard err.	0,5	21,1	1,3	1,3	1,5	0,0
30 V	n =	8	8	8	8	8	8
	Minimum	27,6	398,8	34,9	42,3	5,0	1,3
	Maximum	35,0	740,1	92,5	109,2	42,2	3,1
	Range	7,4	341,3	57,6	66,9	37,2	1,8
	Mean	32,9	651,8	53,4	70,6	16,8	2,1
	Standard dev.	2,3	109,6	19,9	22,0	13,3	0,6
	Standard err.	0,8	38,7	7,0	7,8	4,7	0,2
60 V	n =	8	8	8	8	8	8
	Minimum	31,0	505,4	40,1	52,9	8,4	1,7
	Maximum	35,5	651,1	75,0	94,7	57,0	2,7
	Range	4,5	145,7	34,9	41,8	48,6	1,0
	Mean	32,8	597,1	52,5	72,5	18,6	2,2
	Standard dev.	1,6	61,8	11,4	15,6	15,8	0,4
	Standard err.	0,6	21,9	4,0	5,5	5,6	0,1
90 V	n =	8	8	8	8	8	8
	Minimum	27,8	393,3	43,9	59,6	4,3	1,7
	Maximum	36,5	797,5	63,1	90,0	42,3	2,6
	Range	8,7	404,2	19,2	30,4	38,0	0,9
	Mean	33,4	656,6	50,3	73,1	18,2	2,2
	Standard dev.	2,4	112,4	5,9	10,0	14,3	0,3
	Standard err.	0,8	39,7	2,1	3,5	5,1	0,1

TABLE 2 The effects of duration of current flow on opercular recovery, narcosis and recovery times respectively

		Length (cm)	Mass (g)	Opercular recovery time (s)	Narcosis time (s)	Recovery time (s)	Narcosis coefficient (s cm^{-1})
15 s	n =	8	8	8	8	8	8
	Minimum	32,2	535,7	31,4	40,5	2,4	1,1
	Maximum	36,1	753,4	49,6	50,7	6,2	1,5
	Range	3,9	247,7	18,2	10,2	3,8	0,4
	Mean	34,2	691,4	40,0	45,6	4,2	1,3
	Standard dev.	1,4	73,5	6,1	4,0	1,5	0,1
	Standard err.	0,5	26,0	2,2	1,4	0,5	0,1
30 s	n =	8	8	8	8	8	8
	Minimum	31,0	205,4	40,1	52,9	8,4	1,7
	Maximum	35,5	651,1	75,0	94,7	56,9	2,7
	Range	4,5	145,7	34,9	41,8	48,5	1,0
	Mean	32,8	597,1	52,5	72,5	18,6	2,2
	Standard dev.	1,6	61,8	11,4	15,6	15,8	0,4
	Standard err.	0,6	21,9	4,0	5,5	5,6	0,1
45 s	n =	8	8	8	8	8	8
	Minimum	45,5	1 322,5	48,5	80,0	21,9	1,6
	Maximum	51,0	1 740,5	60,7	119,1	96,6	2,5
	Range	5,5	418,0	12,2	39,1	74,7	0,9
	Mean	47,6	1 507,6	55,3	96,0	47,1	2,0
	Standard dev.	2,5	175,1	5,1	18,4	33,6	0,4
	Standard err.	0,9	61,9	1,8	6,5	11,9	0,1
60 s	n =	8	8	8	8	8	8
	Minimum	39,0	812,4	50,1	64,1	13,4	1,6
	Maximum	46,5	1 365,7	70,6	114,8	36,9	2,5
	Range	7,5	553,3	20,5	50,7	23,5	0,9
	Mean	43,4	1 131,25	58,3	92,2	21,9	2,1
	Standard dev.	3,7	247,4	8,8	21,7	10,3	0,3
	Standard err.	1,3	87,5	2,8	7,7	3,6	0,1

TABLE 3 The effects of rectified current electronarcosis at 3 different water temperatures on opercular recovery, narcosis and recovery times respectively

		Length (cm)	Mass (g)	Opercular recovery time (s)	Narcosis time (s)	Recovery time (s)	Narcosis coefficient (s cm^{-1})
15 °C	n =	8	8	8	8	8	8
	Minimum	31,2	532,5	68,8	92,2	10,3	2,4
	Maximum	43,2	1 285,4	99,9	156,5	63,4	4,0
	Range	12,0	752,9	31,1	64,3	53,1	1,6
	Mean	38,2	961,3	83,7	122,5	25,0	3,2
	Standard dev.	4,4	273,3	14,2	27,5	22,0	0,6
	Standard err.	1,9	122,2	6,4	12,3	9,8	0,3
20 °C	n =	8	8	8	8	8	8
	Minimum	25,1	910,4	40,7	56,4	5,2	1,4
	Maximum	40,7	1 059,6	64,3	156,1	12,8	4,5
	Range	15,6	149,2	23,6	99,7	7,6	3,1
	Mean	33,7	1 008,0	52,4	99,0	8,6	3,0
	Standard dev.	5,0	51,5	8,5	39,7	2,4	1,2
	Standard err.	2,0	21,0	3,5	16,2	1,0	0,5
25 °C	n =	8	8	8	8	8	8
	Minimum	31,5	539,1	30,1	44,4	12,7	1,2
	Maximum	59,2	1 266,2	48,9	154,3	110,0	4,1
	Range	27,7	727,1	18,8	109,9	97,3	2,9
	Mean	39,7	908,1	40,9	73,0	43,7	1,9
	Standard dev.	8,8	238,5	5,9	34,3	35,7	0,9
	Standard err.	3,1	84,3	2,1	12,1	12,6	0,3
	't' Values (df)						
	15/20 (14)	NS	NS	5,349 (P=0,001)	NS	2,096 (P=0,05)	NS
	15/25 (14)	NS	NS	7,872 (P=0,001)	3,184 (P=0,01)	NS	2,600 (P=0,02)
	20/25 (14)	NS	NS	3,143 (P=0,01)	NS	2,774 (P=0,02)	1,991 (P=0,1)

df = degree of freedom; P = two-tailed probability; NS = not significant

and rapid convulsive shudders of the body would commence a few seconds later. These movements made it extremely difficult to determine when the fish were responding to stimuli. On a number of occasions haemorrhaging of the gills was observed, a phenomenon which occurred in all the tests undertaken on carp. In this respect the common carp differed completely in its response to electronarcosis from that exhibited by the freshwater bream *O. mossambicus,* which recovered uneventfully.

The effect of frequency

A preliminary investigation showed that carp exhibited erratic opercular movements and convulsive shudders at frequencies ranging from 25 Hz to 500 Hz, which made it difficult to determine the exact time of first response to a stimulus. Since there were no significant differences in opercular recovery times, narcosis times and recovery times in tilapia narcotized at different frequencies (Barham *et al.*, 1988), the effect of frequency on carp was not investigated further.

The effect of duration of application

The results of duration of application time are presented in Table 2. Current application was not extended beyond a period of 60 s because of severe convulsions. Although mean narcosis times increased with increasing application times up to and including 45 s there was a slight but insignificant decrease when the current flowed for 60 s. This trend was not reflected in the mean narcosis coefficients which did not increase significantly when application times exceeded 30 s. This indicates that the increased narcosis times observed at 45 s and 60 s application times were due to the increased sizes of the fish. Opercular recovery times reflected the narcosis coefficient pattern. The narcosis times for corresponding current flows were in all instances substantially lower in the common carp than the times observed for *O. mossambicus.*

The effects of rectified current electronarcosis

The effect of temperature

Narcosis times declined with increasing water temperatures (Table 3, Fig. 2) but it was only the times at 15 °C and 25 °C that were significantly different (P=0,01). This trend was also evident in mean opercular recovery times. Mean recovery times did not continue this trend and fish subjected to narcosis at 20 °C recovered the quickest, followed by fish narcotized at 15 °C, with those at 25 °C taking the longest time to recover. The narcosis coefficient decreased slightly as the temperature rose from 15 °C to 25 °C but decreased significantly at 25 °C (P = 0,02). Although carp exhibited a similar pattern to tilapia (Barham *et al.*, 1988) the narcosis times for corresponding temperatures were much lower in the common carp.

DISCUSSION

Electronarcosis suggests itself as a cheap and effective alternative to chemical anaesthesia and is free from the carcinogenic hazards often associated with chemical anaesthesia. Barham *et al.* (1987b, 1988, 1989) have shown that the tilapia *O. mossambicus* is an excellent candidate for electronarcosis, with an adequate period of narcosis and an uneventful recovery.

The results obtained in this study clearly suggest that the common carp *Cyprinus carpio* is not a suitable candidate for either alternating or rectified current electronarcosis. The narcosis times induced are, generally, of too short a duration for practical use and the occurrence of haemorrhaging is a further negative aspect. These findings contrast with the findings for the tilapia *O. mossambicus* (Barham *et al.*, 1988, 1989) which is an eminently suitable candidate for electronarcosis.

The reasons for the observed erratic movements of carp are not clear and will need further investigation. Physiological responses of carp to electronarcosis will be reported on in another paper.

ACKNOWLEDGEMENTS

The financial support of the University of Zululand and the Rand Afrikaans University is gratefully acknowledged.

REFERENCES

BARHAM, W. T., SCHOONBEE, H. J. & VISSER, J. G. J., 1987a. The design and development of an alternating current electronarcosis unit for use with freshwater fish. Publication series of the University of Zululand. Series B64, 20 pp.

BARHAM, W. T., SCHOONBEE, H. J. & VISSER, J. G. J., 1987b. The use of electronarcosis as anaesthetic in the cichlid, *Oreochromis mossambicus* (Peters). I. General experimental procedures and the role of fish length on the narcotizing effects of electric currents. *Onderstepoort Journal of Veterinary Research*, 54, 617–622.

BARHAM, W. T., SCHOONBEE, H. J. & VISSER, J. G. J., 1988. The use of electronarcosis as anaesthetic in the cichlid, *Oreochromis mossambicus* (Peters). II. The effects of changing physical and electrical parameters on the narcotizing ability of alternating current. *Onderstepoort Journal of Veterinary Research*, 55, 205–215.

BARHAM, W. T., SCHOONBEE, H. J. & VISSER, J. G. J., 1989. The use of electronarcosis as anaesthetic in the cichlid, *Oreochromis mossambicus* (Peters). III The effects of changing physical and electrical parameters on the narcotizing ability of half-wave rectified current. *Onderstepoort Journal of Veterinary Research*, 56, 67–71.

FERREIRA, J. T., 1979. Bereiding en evaluering van benzocaine-hidrochloried as narkosemiddel vir varswatervis. M.Sc. dissertation, Rand Afrikaans University.

FERREIRA, J. T., 1982. Evaluering van benzocaine-hidrochloried as narkosemiddel vir varswatervis. Ph.D. thesis, Rand Afrikaans University.

SARIG, S., 1987. Fisheries and fish culture in Israel. *Bamidgeh* 39 (4), 95–108.

SMIT, G. L., 1980. The effect of tricaine methane sulphonate and generally used anticoagulants on fish haematology. Ph.D. thesis, University of the Witwatersrand.

SIWICKI, A. & STUDNICKA, 1986. Ceruloplasma activity in carp (*Cyprinus carpio* L) *Bamidgeh* 38 (4), 126–129.

VIOLA, S. & ARIELI, Y., 1983. Evaluation of different grains as basic ingredients in complete fish feeds for carp and tilapia in intensive culture. *Bamidgeh* 35 (2), 38–43.

VIOLA, S., ARIELI, Y., & ZOHAR, G., 1988. Unusual feedstuff (tapioca and lupin) as ingredients for carp and tilapia feeds in intensive culture. *The Israel Journal of Aquaculture—Bamidgeh* 40 (1), 29–34.

Printed by the Government Printer, Private Bag X85, Pretoria, 0001