African Journal of Tropical Hydrobiology and Fisheries 16: 10-15 (2018)

Changes in the Diet of *Synodontis victoriae* and *Synodontis afrofischeri* in Lake Victoria, Tanzanian waters.

MBONI V. ELISON[1*], ENOCK MLAPONI[1], MAGRETH J. MUSIBA[1], GODFREY W. NGUPULA[1], BENEDICTO B. KASHINDYE[1] and ROBERT J. KAYANDA[2]

[1]*Tanzania Fisheries Research Institute, P. O. Box 475, Mwanza, Tanzania.*
[2]*Lake Victoria Fisheries Organization, P. O. Box 1625, Jinja, Uganda.*

*Corresponding author. E-mail: mbonielison@tafiri.go.tz.

Abstract
The diet of *Synodontis victoriae* and *S.afrofischeri* was investigated from samples collected for stomach analysis in May 2013, October 2013, and April 2014 in the Tanzanian waters of Lake Victoria. The diet of *S. victoriae* was dominated by freshwater shrimps *Caridina nilotica* followed by unidentified fish remains, the cyprinids *Rastrineobola argentea* and *Enteromius profundus* as well as insects, molluscs, haplochromines and worms. The diet of *S. afrofischeri* was dominated by *R. argentea* followed by insects, fish remains, worms, molluscs, C. nilotica, algae and haplochromines. There was considerable variation in the diets of both species collected at different times and they displayed considerable plasticity in their diet. Both species exhibited a wider range of diet, utilizing food items that may not have been available before the changes in the lake that followed the Nile perch upsurge in the 1980s.

Keywords: *Caridina nilotica*, Diet expansion, Food and Feeding habits, *Rastrineobola argentea, S*easonal variation

Introduction
Fishes of the genus *Synodontis* (family Mochokidae) are found in freshwaters throughout Africa with two species, *S. victoriae* and *S. afrofischeri*, occurring in Lake Victoria. The smaller species *S. afrofischeri* tends to inhabit water < 20 m deep while *S. victoriae* is more numerous in deeper water (van Oijen, 1995). They made up 3.43% (*S. victoriae* = 3.42%) of the total demersal biomass in the lake in 1969, and the catch rates varied from 0.5 kg hr-1 in the 0-9 m zone to 29.4 kg hr^{-1} in the 60-69 m zone (Kudhongania and Cordone, 1974). After the Nile perch upsurge, which began in 1980, both species declined; the average catch rate in Uganda, for example, fell from 15.4 kg hr^{-1} in 1969-71 to 2.9 kg hr^{-1} in 1981, 0.1 kg hr^{-1} in 1985 and zero in 1986 (Acere, 1988). This coincided with the dramatic decrease of almost all native fish species, notably the haplochromines, in Lake Victoria (Ogutu-Ohwayo, 1990; Witte *et al*., 1992a, b). However, they were taken in trawl catches in the Mwanza Gulf in the 1980s with catch rates up to 75 kg hr^{-1} at 57 m depth although they were much lower (maximum about 20 kg hr^{-1}) in shallow water (Goudswaard and Witte, 1997). The two species have been caught in variable numbers during bottom trawl surveys between 1984 and 2014 (Figure 1).

Little is known about the diet of *Synodontis* species in Lake Victoria but they were reported to feed mostly on molluscs and insects (Eccles, 1992; Witte and de Winter, 1995). Molluscs were reported to be the most important item in the diet of *S. victoriae,* with insects, mainly *Povilla* (Ephemeroptera) and chironomids being important in the diet of *S. afrofischeri* (Corbet, 1961). Witte and de Winter (1995) stated that *S.*

victoriae was able to extract the flesh of snails without crushing their shells. Some fish species in Lake Victoria such as haplochromines (Katunzi et al., 2003; Kishe-Machumu et al., 2008), Nile perch (Kishe-Machumu et al., 2012), Nile tilapia (Njiru et al., 2004) and others (Wanink and Joordens, 2007) have changed or expanded their diet following the changes in the ecology of the lake, it is possible that synodontids diets have changed as well. This study investigated the diet of S. victoriae and S. afrofischeri in Lake Victoria, and examined the extent to which they overlap, and whether or not their diets have changed over time.

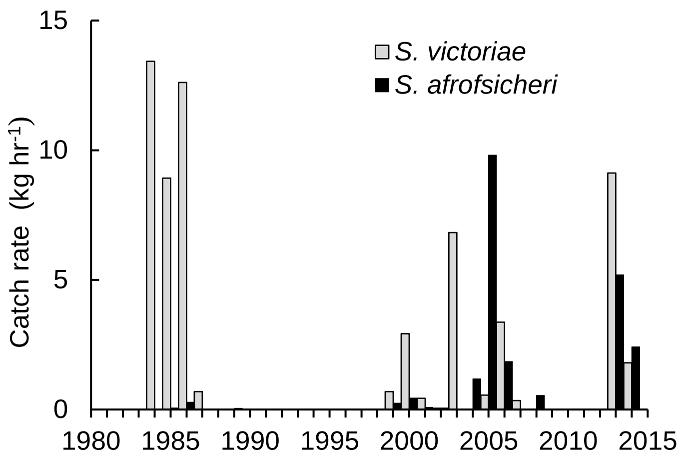

Figure 1. Mean catch rate of S. victoriae at depths above 35m and of S. afrofischeri at various depths in bottom trawls on MV Kiboko (1984 -1990) and RV Explorer (1999 -2014). No sampling was done from 1991-1998 and 2009-2012.

Methods

Lake Victoria has a surface area of 68,000 km2 of which 35,088 km2 (51%) is located in Tanzania. The lake area was divided into five 10-m depth strata from 0-50 m and one stratum from 50-80 m (Figure 2). Fish samples were collected at nine stations in May 2013, five stations in October 2013 and four stations in April 2014 using a 24.5-m long trawl net with a 4-mm mesh cod end mounted on the research vessel Lake Victoria Explorer. The trawling speed was maintained at 3.0-3.5 knots and trawling duration was 30 minutes for each trawl. Trawling was carried out in daylight only, between 0600 and 1800 hours.

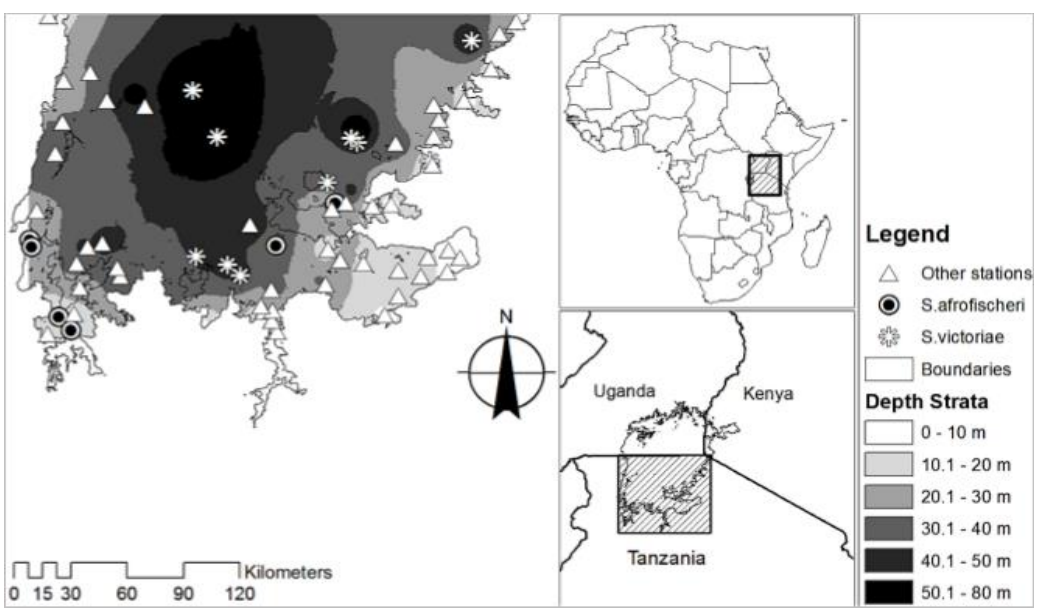

Figure 2. Lake Victoria showing the location of sampling station where *Synodontis* were caught.

Every *Synodontis* in the catch was weighed and measured to standard length (SL). Then the fish were dissected and the gut removed. Before opening the stomach, its fullness was estimated at five levels; 0, 25, 50, 75 and 100%. Identification of stomach contents was performed on board immediately after each haul.

The food items present in the stomach were identified to the lowest possible taxonomic level. The relative importance of each item was determined by frequency of occurrence (%F), which is the proportion of stomachs containing a particular food item out of the total number of the stomachs containing food. Then the volume of each food item was estimated for each fish separately by determining the contribution of each prey items to the total volume of food it had ingested and expressed as a percentage. After that a correction on volume per food type was made for the percentage of fullness of the stomach (Kishe-Machumu *et al.*, 2012).

Results

Specimens of *S. victoriae* were generally larger than those of *S. afrofischeri* (Figure 3). The former ranged from 11.0 to 28.0 cm SL (mean = 17.8 cm) while the latter ranged from 5.0-16.0 cm SL (mean = 11.1 cm). A total of 666 stomachs (373 from *S. victoriae* and 293 from *S. afrofischeri*) were collected and just over 50% of them contained food (Table 1). The most important item in the diet of *S. victoriae* was the atyid shrimp *Caridina nilotica* (%F = 57.1%) followed by unidentified fish remains (19.3%), and the cyprinids *Rastrineobola argentea* (17.9%) and *Enteromius profundus* (12.7%), while other food items recorded included insects, molluscs, haplochromines, and worms. The major food items for *S. afrofischeri* included *R. argentea* (34.0%) and insects (23.1%), followed by unidentified fish remains, worms, molluscs, haplochromines and algae (Table 2).

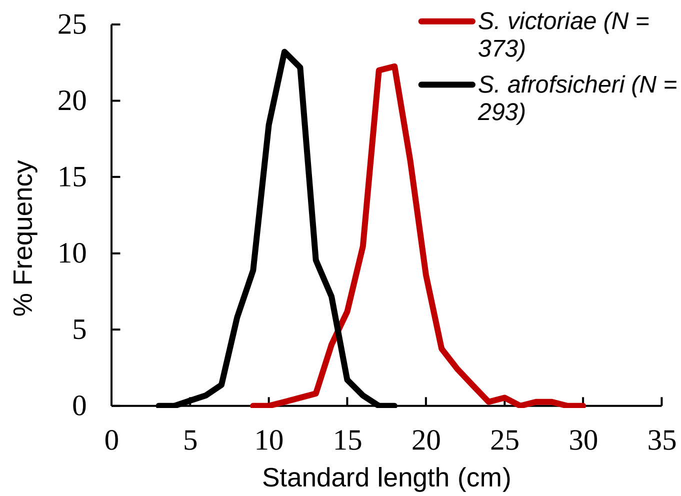

Figure 3. Length-frequency distribution of *Synodontis victoriae* and *S. afrofischeri* from Lake Victoria.

In terms of volume, the diet of *S. victoriae* was again dominated by *C. nilotica* (49.8%), *R. argentea* (15.6%), *E. profundus* (14.9%) and fish remains (14.4%), along small quantities of insects, haplochromines, worms, molluscs and unidentified materials. The diet of *S. afrofischeri* was dominated by *R. argentea* (42.0%) and insects (23.9%) followed by molluscs, worms, fish remains, algae and haplochromines (Table 2).

There was considerable variation in the diet of these synodontids at different sampling times. In May 2013, the diet of *S. victoriae* was dominated with *E. profundus, R. argentea* and fish remains, which together accounted for 97% of all food items but in October 2013 survey, the major item was *C. nilotica*, which made up 83% of their diet. In April 2014 insects and worms were dominant, making up 71% of the diet. In contrast, in May 2013 *S. afrofischeri* fed entirely on insects but in October 2013 it was feeding on worms, *C. nilotica* and insects which together made up 85% of their diet. In April 2014 the diet had shifted to *R. argentea*, molluscs and insects, which accounted for 88% of all food items (Figure 4).

Table 1. The number of *S. victoriae* and *S. afrofischeri* collected from Lake Victoria and the numbers and proportion with food in their stomachs.

Species	Stomachs examined	Stomachs with food
S.victoriae	373	212 (56.8%)
S. afrofischeri	293	156 (53.2%)
Total	666	368

Table 2. Food items in the diets of *S. victoriae* and *S. afrofischeri* in Lake Victoria, expressed as frequency of occurrence (%F) and volume (%V).

	S. victoriae		*S. afrofischeri*	
Food items	%F	%V	%F	%V
C. nilotica	57.1	49.8	7.1	3.9
Fish remains	19.3	14.5	11.5	8.3
R. argentea	17.9	15.6	34.0	42.0
E. profundus	12.7	14.9	0	0
Insects	7.6	2.8	23.1	23.9
Molluscs	2.4	0.5	10.3	12.1
Haplochromines	1.4	1.1	0.6	0.2
Worms	0.5	0.6	11.5	8.7
Unidentified material	0.5	0.3	0	0
Algae	0	0	0.6	0.9

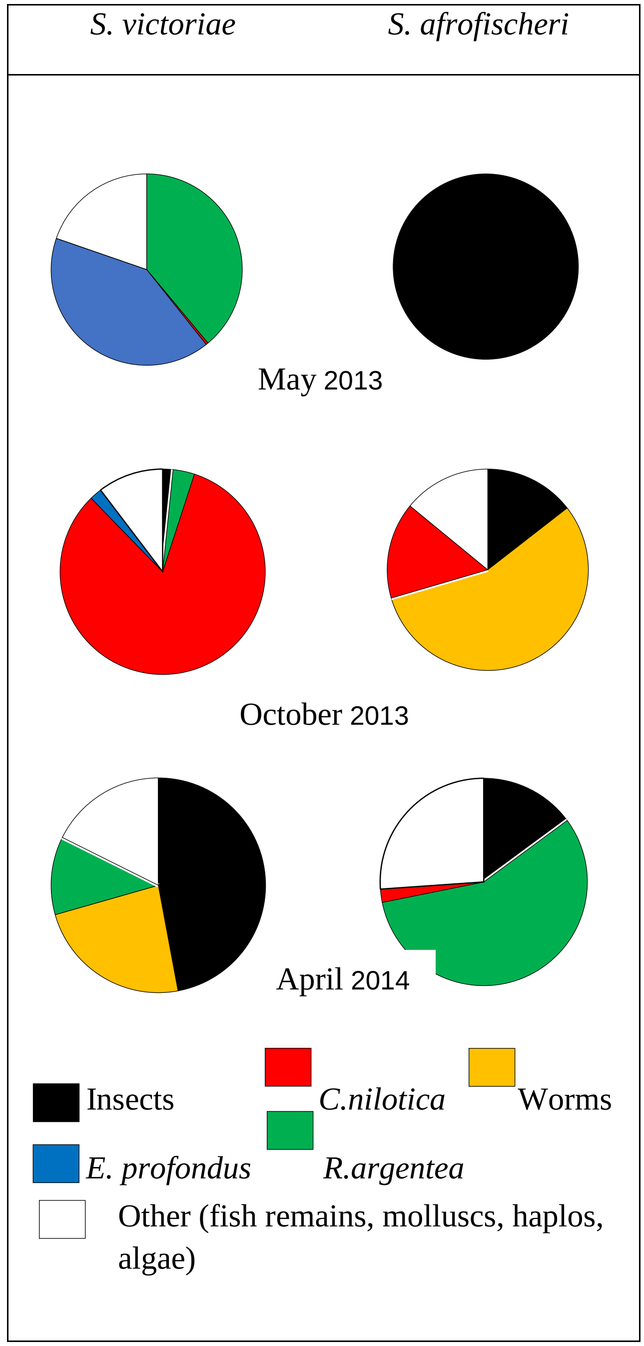

Figure 4. Percentage contribution of different prey items in the diet of *S. victoriae* *and S. afrofsicheri* in Lake Victoria in May 2013, October 2013 and April 2014.

Discussion

Both of these species in Lake Victoria have flexible diets and were evidently feeding on the most abundant food items available at the time of sampling. In this respect, they were similar to other synodontids such as *S. zambezensis* in Lake Kariba, which exhibited considerable plasticity in its diet and fed on prey that were most abundant. Its diet also changed in response to ecological changes in the lake; in the 1970s when floating mats of the Kariba weed *Salvinia molesta* covered large areas of the lake it fed mostly on insects that lived on or under the weed mats but it switched to molluscs after the weed disappeared (Mitchell, 1976; Sanyanga, 1998). In the Sudd swamps of the White Nile *S. frontosus* ingested large quantities of benthic detritus, along with insects and crustacea, while molluscs and fish became more important in the diet of *S. schall* (Hickley and Bailey, 1987). *S. membranaceous* from Jeba Lake in Nigeria had a wide range of food items including detritus, plant, seed, gastropods and insects (Owolabi, 2008). Corbet (1961) reported that *S. victoriae* fed mostly on molluscs and insects and the increased incidence of *Caridina* and *Rastrineobola* in their diet presently reflects the fact that these two species increased dramatically after the Nile perch upsurge (Witte *et al.*, 1992a; Budeba, 2003; Goudswaard *et al.*, 2006) and ecological changes in Lake Victoria.

The food and feeding habits of fish can vary from time to time depending on changes in the composition of prey organisms occurring at different seasons of the year (Bhuiyan *et al.*, 1999, Pombo *et al.*, 2013). Thus, the contribution of *C. nilotica* was high in October, the short rain season, a time when these shrimps were reported to be most numerous (Budeba and Cowx, 2007). In contrast, the contribution of *R. argentea* tended to be greatest in May 2013, the long rain season, and there may be an inverse relationship between the abundance of *C. nilotica* and *R. argentea* (Budeba and Cowx, 2007).

The diet of *S. afrofischeri* was formerly dominated by insects and molluscs (Corbet, 1961; Witte and van Densen, 1995) and the appearance of *Rastrineobola* and *Caridina* in its diet also reflects the changes that have taken place in the lake. Its diet also varied according to season and food availability; in May 2013, for example, they fed exclusively on insects, in September 2013 and April 2014 its diet was dominated by worms and *R. argentea* respectively.

Both *Synodontis* species appear to be generalists, feeding on a wide spectrum of different foods, and the ecological changes in Lake Victoria may have created new food sources for them. In particular, competition from the more specialised haplochromines, which may have suppressed *Caridina*, seems to have enabled them to utilise food that was previously unavailable. This is yet another example of the way in which the surviving native fish species have adapted to the new environmental conditions in Lake Victoria.

Acknowledgements

We wish to express our appreciation to Trade and Agriculture Support Programme Phase II **(**TASP II) for financial support. We also thank TAFIRI management especially the Director General for permission granted to the scientists to conduct the study. We wish to thank Mr Charles Mashafi for producing the map of Lake Victoria showing sampling stations. Lastly, our sincere thanks go to the TAFIRI technicians and crew who worked in a team work spirit and supporting each other to make this investigation a success.

References

Acere, T.O. (1988). Recent trends in the fisheries of Lake Victoria (Uganda northern part). *In* Committee for Inland Fisheries of Africa, 1988 Report of the fourth session of the Sub-Committee for the development and management of the fisheries of Lake Victoria. Kisumu, Kenya, 6–10 April 1987. *FAO Fisheries Report* No. 388:36-45.

Budeba, Y.L. (2003). The role of *Caridina nilotica* (Roux 1833) in the Lake Victoria fisheries, Tanzanian waters. PhD Thesis, University of Hull.

Budeba, Y.L. and Cowx, I.G. (2007). Contribution of *Caridina nilotica* (Roux) in the dagaa fishery in Lake Victoria, Tanzania. *Aquatic Ecosystem Health and Management* **10**:381-391.

Bhuiyan, A.S., Nessa, Q. and Hossain, M.D. (1999). Seasonal pattern of feeding of grey mullet, *Mugil cephalus* (L.) (Mugiliformes: Mugilidae). *Pakistan Journal of Zoology* **31**:295-297.

Corbet, P.S. (1961). The food of non–cichlid fishes in the Lake Victoria basin, with remarks on their evolution and adaptation to lacustrine conditions.

Proceedings of the Zoological. Society of. London **136**:1-101.
Eccles, D.H. (1992). *Field Guide to the Freshwater Fishes of Tanzania*. FAO species identification sheets for fishery purposes. FAO, Rome.
Goudswaard, P.C., Witte, F. and Wanink, J.H. (2006). The shrimp *Caridina nilotica* in Lake Victoria (East Africa), before and after the Nile perch increase. *Hydrobiologia* **563**:31-44.
Goudswaard, K. P. and Witte, F. (1997). The catfish fauna of Lake Victoria after the Nile perch upsurge. *Environmental Biology of Fishes* **49**:21-43.
Hickley, P. and Bailey, R.G. (1987). Food and feeding relationships of fish in the sudd swamps (River Nile, southern Sudan). *Journal of Fish Biology* **30**:147-159.
Mitchell, S.A. (1976). The marginal fish fauna of Lake Kariba. *Kariba Studies* No. 8:109-162. National Museums and Monuments of Rhodesia, Salisbury.
Katunzi, E.F.B., Zoutendijk, J., Goldschmidt, T., Wanink, J.H. and Witte, F. (2003). Lost zooplanktivorous cichlid from Lake Victoria reappears with a new trade. *Ecology of Freshwater Fish* **12**:237-240.
Kishe-Machumu M, Witte F & Wanink J.H (2008). Dietary shift in benthivorous cichlids after the ecological changes in Lake Victoria. *Animal Biology* **58**:401-417.
Kishe-Machumu, M., Witte, F., Wanink, J.H. and Katunzi, E.F.B. (2012). The diet of Nile perch, *Lates niloticus* (L.) after resurgence of haplochromine cichlids in the Mwanza Gulf of Lake Victoria. *Hydrobiologia* **682**:111-119.
Kudhongania, A.W. and A.J. Cordone, (1974) Bathospatial distribution patterns and biomass estimates of major demersal fishes in Lake Victoria. *J.Trop.Hydrobiol.Fish,* 3:15–31
Njiru, M., Okeyo-Owuor, J.B., Muchiri, M. and Cowx, I.G. (2004). Shifts in the food of Nile tilapia, *Oreochromis niloticus* (L.) in Lake Victoria, Kenya. *African Journal of Ecology* **42**:163-170.
Ogutu-Ohwayo, R. (1990). The decline of the native fishes of lakes Victoria and Kyoga (East Africa) and the impact of introduced species, especially the Nile perch, *Lates niloticus*, and the Nile tilapia, *Oreochromis niloticus*. *Environmental biology of fishes* **27**: 81-96.
Owolabi, O.D. (2008). The dietary habits of the upside-down catfish, *Synodontis membranaceus* (Osteichthyes: Mochokidae) in Jebba lake, Nigeria. *Revista de Biología Tropical* **56**:931-936.
Pombo, M., Denadai, M.R. and Turra, A. (2013). Seasonality, dietary overlap and the role of taxonomic resolution in the study of the diet of three congeneric fishes from a tropical bay. *PLoS ONE*, **8**(2), e56107.
Sanyanga, R.A. (1998). Food composition and selectivity of *Synodontis zambezensis* (Pisces: Mochokidae) in Lake Kariba, Zimbabwe, and the ecological implications. *Hydrobiologia* **306**:67-78.
van Oijen, M.J.P. (1995) Appendix I. Key to the Lake Victoria fishes other than haplochromine cichlids. *In*: F. Witte & W.L.T. van Densen (eds) *Fish Stocks and Fisheries of Lake Victoria: A Handbook for Field Observations*. Samara Publishing, Cardigan, UK: pp. 209-300.
Wanink, J.H. and Joordens, J.C.A. (2007). Dietary shifts in *Brycinus sadleri* (Pisces: Characidae) from southern Lake Victoria, *Aquatic Ecosystem Health & Management* **10**:392-397.
Witte F &. Van Densen W.L.T (1995) Fish Stocks and Fisheries of Lake Victoria: A Handbook for Field Observations, Samara Publishing Ltd., Dyfed. Great Britain.
Witte F., Goldschmidt T., Goudswaard P.C., Ligtvoet W., van Oijen M.J.P. & Wanink J.H. (1992a). Species extinction and concomitant ecological changes in Lake Victoria. *Netherlands Journal of Zoology* **42**:14–232.
Witte, F., Goldschmidt, T., Wanink, J., van Oijen, M., Goudswaard, K., Witte-Maas, E., Bouton, N. (1992b). The destruction of an endemic species flock: quantitative data on the decline of the haplochromine cichlids of Lake Victoria. *Environmental Biology of Fishes* **34**: 1-8.
Witte, F. and de Winter, W. (1995). Appendix II. Biology of the major fish species of Lake Victoria. p. 301-320. *In*: F. Witte and W.L.T. van Densen (eds) *Fish stocks and fisheries of Lake Victoria. A handbook for field observations*. Samara Publishing, Cardigan, UK: pp. 301-320.