

Diversity and Distribution of Macrophytes in a Freshwater Wetland, Lobo Swamp (Rift Valley) Kenya

Authors: Muasya, A. Muthama, Hover, Victoria C., Ashley, Gail M., Owen, R. Bernhart, Goman, Michelle F., et al.

Source: Journal of East African Natural History, 93(1) : 39-47

Published By: Nature Kenya/East African Natural History Society

URL: [https://doi.org/10.2982/0012-8317\(2004\)93\[39:DADOMI\]2.0.CO;2](https://doi.org/10.2982/0012-8317(2004)93[39:DADOMI]2.0.CO;2)

BioOne Complete (complete.BioOne.org) is a full-text database of 200 subscribed and open-access titles in the biological, ecological, and environmental sciences published by nonprofit societies, associations, museums, institutions, and presses.

Your use of this PDF, the BioOne Complete website, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at www.bioone.org/terms-of-use.

Usage of BioOne Complete content is strictly limited to personal, educational, and non - commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

BioOne sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

**DIVERSITY AND DISTRIBUTION OF MACROPHYTES IN A
FRESHWATER WETLAND, LOBOI SWAMP (RIFT VALLEY)
KENYA**

A. Muthama Muasya

East African Herbarium, National Museums of Kenya
P.O. Box 45166, Nairobi 00100, Kenya
muthamamuasya@yahoo.com

Victoria C. Hover

Dept. of Earth and Environmental Sciences, Rutgers University
Newark, NJ 07081-1819, USA
vhover@andromeda.rutgers.edu

Gail M. Ashley

Dept. of Geological Sciences, Rutgers University
Piscataway, NJ 08854-8066, USA
gmashley@rci.rutgers.edu

R. Bernhart Owen

Dept. of Geography, Hong Kong Baptist University
Hong Kong, China
owen@hkbu.edu.hk

Michelle F. Goman

Dept. of Earth and Atmospheric Sciences, Cornell University
Ithaca, NY 14853-1505, USA
goman@geology.cornell.edu

Michael Kimeli

Friends of Nature Bogoria
P.O. Box 64, Marigat, Kenya
kimeli90@yahoo.com

ABSTRACT

An inventory of Loboï swamp was undertaken to determine the macrophyte diversity and distribution. A total of 36 vascular plant species in 13 families were recorded, with Cyperaceae forming over 30% of macrophytes. Two vegetation zones were observed, characterised by the presence of *Typha* and papyrus. The *Typha* zone, comprising over 70% of the swamp, is dominated by *T. domingensis* and is species rich with 35 plant species whereas the papyrus zone includes the dominant *Cyperus papyrus* and only one other macrophyte species. Distribution of macrophytes is

correlated with depth and period under water, with the *Typha* zone seasonally flooded while the papyrus zone is permanently under water at depths over 0.5m. Water chemistry has little influence on the distribution of macrophytes in the swamp, but at the edges there is predominance of *Cyperus laevigatus* in high alkalinity soils. Current uses of the swamp include dry season grazing, harvesting of papyrus and other plant material for mat making and house thatching, and use of the swamp water for domestic and irrigation agriculture. Further monitoring is needed to evaluate the effect of the resource uses on the swamp.

INTRODUCTION

The lakes and wetlands of the East African Rift Valley are important to Kenya and the world. The valley is known as the “cradle of mankind” and preserves clues to the physical environment in which humans evolved. Many water bodies occur within the Rift Valley, but not all are potable. Water chemistry ranges from saline-alkaline (*e.g.* Lake Bogoria) to fresh (*e.g.* Lake Baringo) (figure 1; Hover *et al.*, unpublished data). These

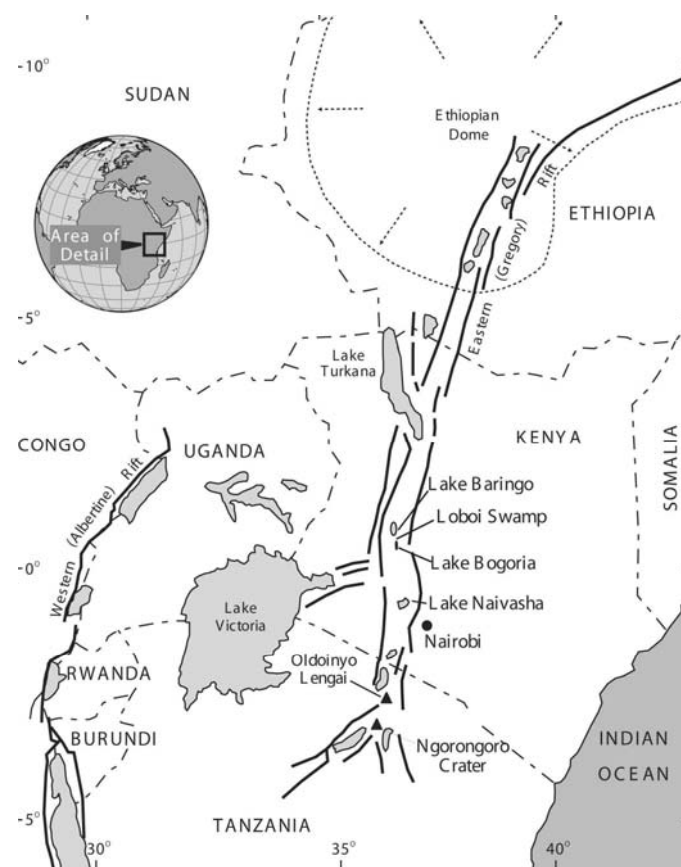


Figure 1. Regional map of East Africa showing the eastern (Gregory) Rift Valley and some of the major lakes and craters. The study area is located between Lake Bogoria and Lake Baringo, Kenya, just north of the equator.

lakes commonly have a unique biodiversity, such as endemic fish in Lake Baringo; and Lakes Baringo, Bogoria, Nakuru and Naivasha are protected under the Ramsar Convention as wetlands of international importance especially as waterfowl habitats (http://www.wetlands.org/RDB/africa/Kenya_sites.html). While the sedimentology and geochemistry of the lakes have been studied extensively over the last few decades (Renaut *et al.*, 1986; Renaut, 1993; Renaut & Tiercelin, 1994), little attention has been given recently to the associated freshwater wetland environments. Lake Naivasha is an exception, and there has been concerted efforts to study the biodiversity, physical and chemical status of the lake and surrounding wetlands (Gaudet & Melack, 1981; Harper *et al.*, 1995; Gouder de Beauregard *et al.*, 1998; Everard *et al.*, 2002; Tarras-Wahlberg *et al.*, 2002). Specifically, little is known about the (1) water sources for the wetlands in these arid settings, (2) quality of water, or (3) expected longevity of the wetlands. As part of an interdisciplinary research program to better understand the ecology of wetlands in arid settings, a field based study of the diversity and distribution of macrophytes was undertaken in Loboï swamp (just north of Lake Bogoria) to inventory the vascular plant community, to determine a water budget for the swamp, and to assess water quality.

Loboï swamp, dating back to about 700 years before present, is an oasis in the dry and arid Lake Bogoria region in the Kenya Rift Valley (Ashley *et al.*, 2004). The swamp is among the limited and scattered sources of fresh water in the area where annual rainfall is erratic and averages 700 mm/year and the potential evaporation exceeds 2,500 mm/year (LaVigne & Ashley, 2001). Loboï swamp is recharged by at least two springs sourced in faults at the valley margin, several small ephemeral surface streams and the Loboï River (Ashley *et al.*, 2002). The swamp is used for both domestic and irrigation water for the surrounding communities, fodder for domestic animals and wildlife, and a source of thatching and mat-making materials.

METHODS

Data were collected in July and September 2002, coinciding with the wet and dry seasons, respectively. The area covered by the swamp was recognized by presence of the wetland macrophytes *Typha* (*Typha domingensis*) and papyrus (*Cyperus papyrus*), and mapped using a GPS (Global Positioning System). Distribution of macrophytes was studied along 15 representative line transects made from the edge of the swamp into the papyrus vegetation. Observations were made at sampling points at 20 m intervals, referenced with GPS readings, to include a record of all plants, the water depth and water samples taken for analyses of water quality parameters (pH, conductivity, alkalinity, ions). Field determinations of the plant species encountered were made using standard field guides for plants (Haines & Lye, 1983; Agnew & Agnew, 1994) with reference specimens collected using non-destructive sampling methods (Forman & Bridson, 1992). Voucher specimens have been deposited for long-term storage at the East African Herbarium (EA) and duplicate copies deposited at the Lake Bogoria National Reserve Headquarters.

RESULTS

The swamp, measuring about 3.5 km by 0.5 km and with total area 1.5 km², is deepest at the southern end with water about 2 meter deep and gradually becoming shallow towards the

north away from the spring sources (figure 2). Two vegetation zones are observed in the swamp, defined by the distribution of *Typha* and papyrus. Areas covered by papyrus have permanent standing water over 0.5 m deep and macrophytes grow on a floating root mat, whereas areas occupied by *Typha* are only seasonally immersed.

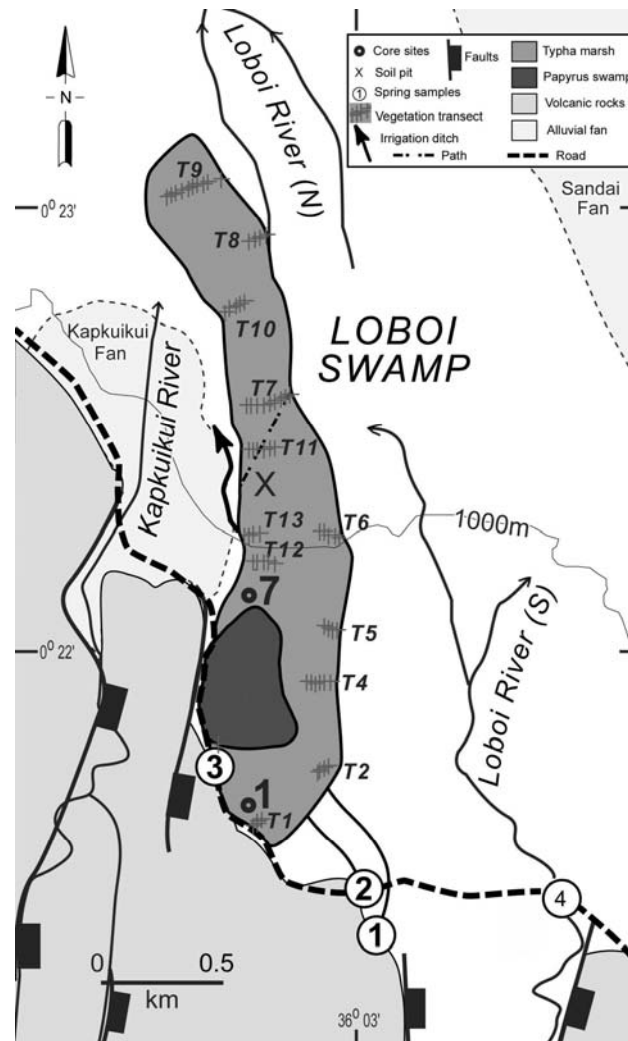


Figure 2. Map of Loboï Swamp showing macrophyte distribution and various sampling points.

A total of 36 vascular plant species in 13 families were recorded in the swamp (table 1). The *Typha* zone is the largest and contains the most species in Loboï swamp, with the exception of papyrus. *Typha domingensis* is almost always found growing together with *Leersia hexandra* and *Ipomoea aquatica*, and other species (table 1) scattered within. Restricted distribution was observed for *Cyperus laevigatus*, which is mostly localised at the southern margins of the swamp, and most in the interface between the *Typha* and wooded vegetation (figure 2; between spring sampling point 3 and T5). Two smaller patches dominated by *C. articulatus* and *C. latifolius* are observed on the eastern margin of the

swamp (figure 2, around T4 and T5). The papyrus zone is nearly a pure stand of *C. papyrus* which forms floating mats on standing water, with scattered *Vigna luteola* vines climbing on the papyrus.

Table 1. Vascular plants recorded in Loboï swamp. Zone E refers to edge of swamp, T to Typha and P to papyrus

FAMILY	SPECIES	ZONE
AMARANTHACEAE	<i>Achyranthes aspera</i> L.	T
	<i>Alternanthera pungens</i> H.B.K.	T
ASTERACEAE	<i>Crassocephalum picridifolium</i> (DC.) S.Moore	T
	<i>Pluchea bequaertii</i> Robyns	T
	<i>Pluchea ovalis</i> DC.	T
COMMELINACEAE	<i>Commelina benghalensis</i> L.	T
	<i>Commelina elgonensis</i> Bullock	T
CONVOVULACEAE	<i>Ipomoea aquatica</i> Forsk.	T
CURCUBITACEAE	<i>Oreosyce africana</i> Hook.f.	T
	<i>Zehneria scabra</i> (L.f.) Sond.	T
CYPERACEAE	<i>Bolboschoenus maritimus</i> (L.) Palla	T
	<i>Cyperus articulatus</i> L.	T
	<i>Cyperus laevigatus</i> L.	T
	<i>Cyperus latifolius</i> Poir.	T
	<i>Cyperus papyrus</i> L.	P
	<i>Cyperus rotundus</i> L.	T
	<i>Cyperus</i> sp.	T
	<i>Fimbristylis complanata</i> (Retz.) Nees	T
	<i>Fuirena pubescens</i> (Poir.) Kunth	T
	<i>Pycreus mundtii</i> Nees	T
FABACEAE	<i>Acacia seyal</i> Del.	T/E
	<i>Acacia tortilis</i> (Forssk.) Hayne	T/E
	<i>Senna didymobotrya</i> (Fresen.) Irwin & Barneby	T
	<i>Sesbania sesban</i> (L.) Merr.	T
	<i>Vigna luteola</i> (Jacq.) Benth	T/P
LEMNACEAE	<i>Lemna perpusilla</i> Torrey	T/P
MALVACEAE	<i>Hibiscus cannabinus</i> L.	T
	<i>Hibiscus diversifolius</i> Jacq.	T
NYMPHAEACEAE	<i>Nymphaea nouchali</i> Burm.f.	?T
ONAGRACEAE	<i>Ludwigia leptocarpa</i> (Nutt.) Hara	T
POACEAE	<i>Cynodon dactylon</i> (L.) Pers.	T
	<i>Echinochloa pyramidalis</i> (Lam.) Hitchc.	T
	<i>Leersia hexandra</i> Sw.	T
	<i>Panicum repentellum</i> Napper	T
	<i>Paspalidium germinatum</i> (Forssk.) Stapf	T
	<i>Typha domingensis</i> Pers.	T

Water chemistry results from several sampling points are summarized in table 2. Various sampling points show small differences in the pH, conductivity and quantities of dissolved substances. An exception is the second sample (*C. laevigatus*, Brown Water), which has

Table 2. Lobo swamp water chemistry.

Sample Type	pH	Cond mS/cm	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l	NO ₃ mg/l	SO ₄ mg/l	Total Alk as HCO ₃ mg/l	Total Alk meq/l	GPS Lat (Deg Min)	GPS Lon (Deg Min)
Papyrus zone	7.16	0.635	7.333	1.97	136	17.5	9.70	0.90	9.70	383.1	6.279	N00 21.843	E036 02.687
<i>C. laevigatus</i> (Brown Water)	8.16	5.360	20.193	6.79	1290	136	5.30	0.50	7.30	3762.0	61.660	N00 21.608	E036 02.745
<i>C. laevigatus</i> / <i>Cynodon</i> (T4)	7.03	0.841	13.612	2.46	184	14.3	4.40	0.70	3.10	543.9	8.913	N00 21.936	E036 02.932
<i>C. laevigatus</i> (T5)	7.07	0.762	13.453	2.40	169	15.8	7.90	0.50	1.70	510.0	8.358	N00 22.050	E036 02.964
<i>C. latifolius</i> (T4)	6.87	0.630	8.626	1.51	131	15.4	8.20	1.00	5.10	398.1	6.525	N00 21.935	E036 02.916
<i>Typha</i> / <i>C. latifolius</i> (T5)	6.87	1.006	26.653	4.60	202	18.6	5.40	0.40	1.60	676.9	11.090	N00 22.058	E036 02.943
<i>Typha</i> zone	7.47	0.661	7.375	1.86	140	17.8	9.10	1.50	9.50	415.7	6.813	N00 21.625	E036 02.778
Irrigation Grove	7.21	0.640	7.397	1.67	150	16.9	8.30	0.20	4.00	409.7	6.714	N00 22.064	E036 02.727

higher values of sodium, potassium and carbonate ions, and consequently higher conductivity and more alkalinity. This sampling point has distinctly brownish water and is dominated by *C. laevigatus*. Other sampling points that contain *C. laevigatus* have water chemistry values more similar to habitats that support other macrophytes.

DISCUSSION

Topographic maps made in the 1970's show the swamp extending into the Loboï plain north of Lake Bogoria (Survey of Kenya, 1979). Field visits in 2002 established a 60% reduction in the size of the swamp to about 1.5 km² over the last 30 years. While the average rainfall recorded in Bogoria has remained nearly constant (LaVigne & Ashley, 2001), there has been an increased withdrawal of water from the swamp for irrigation purposes. The irrigation canal utilising the swamp water was dug in the early 1970s and it is evident that there is increased demand for water for cultivation. Vegetables and maize are now grown for local consumption and sale to outside markets. Since the recent El Niño rains (1997-98), Loboï River has changed course and is no longer flowing into the wetland.

Species diversity is high within the *Typha* zone but low in the papyrus zone. Over 30% of the macrophytes belong to the Cyperaceae, a family which is dominant in wetlands (Haines & Lye, 1983). Data from pollen analysis (Ashley *et al.*, 2004) show an increase in Cyperaceae pollen since the last 700 years, evidence which is supported by the current vegetation observations. Within the papyrus zone, the climax community dominated by floating *C. papyrus* is observed growing in near pure mono-stands. Similar observations of mono-stands of papyrus have been recorded in other wetlands in East Africa (Ssegawa, 2001). Loboï Swamp lacks submerged macrophytes, which are frequently observed in shallow open water in fresh water wetlands in Kenya (Harper *et al.*, 1995; Gouder de Beauregard *et al.*, 1998). This absence of submerged macrophytes can be attributed to the absence of open water in the papyrus zone.

The observed macrophyte distribution appears to be influenced by water availability. *Typha* and associated species (table 1) are rooted on ground that has fluctuating water levels (periodic submergence or drying), whereas papyrus forms floating mats. Presence of water throughout the year versus seasonal drying may be a major factor in determining the zonation and composition of the plants into papyrus and *Typha* zones in Loboï. In comparison, Lake Naivasha has little *Typha* and papyrus is found rooted at the lake edge in drying mud as well as floating above deeper water (Mavuti, pers. com.). In Ugandan wetlands, papyrus has been observed to grow in broad habitats as long as the habitat is sometimes flooded (Ssegawa *et al.*, 2004). The difference in distribution of the macrophytes between Loboï and Naivasha raises question as to whether other factors such as soil type are influencing the observed distribution patterns. In general, fluctuation in water level has been shown to be among the important factors influencing plant distribution in wetlands (Keddy & Fraser, 2000).

Water chemistry data from the papyrus and *Typha* zones is fairly similar. Most macrophytes grow in substrate that is slightly acid to basic, but only *C. laevigatus* is also observed in highly alkaline soils (table 2). *Cyperus laevigatus* is commonly growing at the edge of the swamp, in areas which have brownish water, or which have a brownish crust of top soil. Such brownish colour is perhaps due to the presence of carbonate and indicates high alkalinity conditions. *Cyperus laevigatus* and *Sporobolus spicatus* (Vahl) Kunth are recorded growing in high alkalinity soils at the shores of Lake Bogoria (Onkware, 2000).

No invasive alien macrophytes were recorded. Introduction of invasive macrophytes is increasingly an environmental concern in Kenya, with water hyacinth (*Eichhornia crassipes* (C.Martius) Solms-Laub.) dominating the shallow shore of Lake Victoria and recorded in several other fresh water bodies. *Prosopis juliflora* DC., an introduced legume shrub which is now invading semi-arid areas in Eastern Africa, was observed growing on dry soil on the edges of the swamp in 2002.

The local communities are using the Loboï swamp resources in various ways. The swamp is an important source of drinking water for people and their herds, and supports irrigated agriculture. During the dry season, the *Typha* zone is nearly the only source of fodder for the cattle which graze on *Typha* and other plants in the swamp. The local women are organised into self-help groups to exploit papyrus stems for mat-making and *Typha* for house thatching, a venture likely to grow as more members join the group. As more members of the community exploit the swamp, there is danger of unsustainable exploitation. Studies are needed to quantify the optimum levels of water use or harvesting of papyrus stems in a sustainable manner.

ACKNOWLEDGMENTS

Research was carried out under a permit (MOEST 13/001/31C 103) from the Ministry of Education, Science and Technology of Kenya. Research was supported by NSF GEO grant #EAR-0207705 to G.M. Ashley and V.C. Hover, and by a Hong Kong Baptist University Faculty Research Grant (FRG/02-03/II-15) to R.B. Owen. Acknowledgment is made to the Donors of the Petroleum Research Fund, administered by the American Chemical Society for partial support of this research (PRF 36498-AC8, Hover). We are appreciative to Dr. Karega-Munene, Head of Archaeology, National Museums of Kenya (NMK) for assistance with logistics. We are especially grateful to William Kimosop, Senior Warden for the Lake Bogoria National Reserve for his encouragement with the research. We appreciate the discussions with Musa Cheruiyot and Fabian Musila, Lake Bogoria Community Based Wetlands Project and Dr. Nathan Gichuki, Wetlands Department (NMK).

REFERENCES

- Agnew, A.D.Q. & S. Agnew (1994). *Upland Kenya Wild Flowers*. East African Natural History Society, Nairobi.
- Ashley, G.M., M.F. Goman, V.C. Hover, R.B. Owen, R.W. Renaut, & A.M. Muasya (2002). Artesian blister wetlands, a perennial water resource in the semi-arid rift valley of East Africa. *Wetlands* **22**(4): 686–695.
- Ashley, G.M., J. Maitima Mworio, A.M. Muasya, R.B. Owen, S.G. Driese, V.C. Hover, R.W. Renaut, M.F. Goman, S. Mathai, & S.H. Blatt (2004). Sedimentation and recent history of a freshwater wetland in a semi-arid environment, Loboï Swamp, Kenya, East Africa. *Sedimentology* **51**: 1–21.
- Gouder de Beauregard, A.-C., D. Harper, F. Malaisse & J.-J. Symoens (1998). Dynamique récente et cartographie de la végétation aquatique (1960-1996) du lac Naivasha (Rift Valley, Kenya). *Mededelingen der Zittingen van de Koninklijke Academie voor Overzeese Wetenschappen* **44**: 373–389.

- Everard, M., A. Kuria, M. Macharia, J.A. Vale & D.M. Harper (2002). Aspects of the biodiversity of the rivers in the Lake Naivasha catchment. *Hydrobiologia* **488**: 21–41.
- Foreman, L. & D. Bridson (1992). *The Herbarium Handbook*. Royal Botanic Gardens, Kew.
- Gaudet, J.J & J.M. Melack (1981). Major ion chemistry in a tropical lake basin. *Freshwater Biology* **11**: 309–333.
- Haines, R. W. & K. A. Lye (1983). *Sedges and Rushes of East Africa*. East African Natural History Society, Nairobi.
- Harper, D.M., C. Adams & K.M. Mavuti (1995). The aquatic plant communities of the lake Naivasha wetland, Kenya: pattern, dynamics and conservation. *Wetlands Ecology and Conservation* **3**(6): 111–123.
- Keddy, P. & L.H. Fraser (2000). Four general principles for the management and conservation of wetlands in large lakes: The role of water levels, nutrients, competitive hierarchies and centrifugal organization. *Lakes & Reservoirs: Research and Management* **5**: 177–185.
- LaVigne, M. & G.M. Ashley (2001). Climatology and rainfall patterns: Lake Bogoria National Reserve (1976–2001). Rutgers University, New Brunswick, NJ, USA, unpublished report.
- Onkware, A.O. (2000). Effect of soil salinity on plant distribution and production at Loburu delta, Lake Bogoria National Reserve, Kenya. *Austral Ecology* **25**: 140–149.
- Renaut, R.W., J.J. Tiercelin, & R.B. Owen (1986). Mineral precipitation and diagenesis in the sediments of the Lake Bogoria basin, Kenya Rift Valley. In L.E. Frostick, R.W. Renaut, I.Reid & J.J. Tiercelin (eds), *Sedimentation in the African Rifts*. Geological Society Special Publication No. 25, Oxford. Pp. 159–175.
- Renaut, R.W. (1993). Zeolitic diagenesis of late Quaternary fluviolacustrine sediments and associated calcrete formation in the Lake Bogoria Basin, Kenya Rift Valley. *Sedimentology* **40**: 271–301.
- Renaut, R. W. & J.J. Tiercelin (1994). Lake Bogoria, Kenya Rift Valley- a sedimentological overview. In R. W. Renaut & W. M. Last (eds.), *Sedimentology and Geochemistry of Modern and Ancient Saline Lakes*. SEPM (Society for Sedimentary Geology) Tulsa, OK, USA. Special Publication 50. Pp.101–123.
- Ssegawa, P. (2001). The diversity and distribution of sedges in selected important bird areas of Uganda. Unpublished MSc. Thesis, Makerere University.
- Ssegawa, P., E. Kakudidi, M. Muasya & J. Kalema. 2004. Diversity and distribution of sedges on multivariate environmental gradients. *African Journal of Ecology* **42**(1): 21–33.
- Survey of Kenya (1979). *Ngeleshi* 1:50,000 topographic map. Survey of Kenya, Nairobi.
- Tarras-Wahlberg, H., M. Everard & D.M. Harper (2002). Geochemical and physical characteristics of river and lake sediments at Naivasha, Kenya. *Hydrobiologia* **488**: 21–41.