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Establishment of the Presence of Moth: *Niphograpta albiguttalis* (Warner) (Lepidoptera: Pyralidae), Biological Control Agent of Water Hyacinth (*Eichhornia crassipes*) in Waterways of Lagos and Ogun States, Southwestern Nigeria

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Abstract: *Neochetina eichhorniae* and *Neochetina bruchi* (weevils), biological control agents of water hyacinth *Eichhornia crassipes* were released on the waterways of the following West African countries: Ghana, Benin and Nigeria to curtail the menace of water hyacinth in this region. Releases were made in 1994, 1991 and 1993 for *N. eichhorniae*, respectively and 1994, 1992 and 1995 for *N. bruchi*, respectively. These weevils became successfully established in these countries. But for an achievement of sufficient control a moth *Niphograpta albiguttalis* another biological control agent was released only in Ghana in 1996 and in Benin in 1993 excluding Nigeria, to complement the damage caused by the weevils but this moth did not become successfully established in these countries. Without record of release of this moth in Nigeria however, in 2009 the larvae of this moth were found damaging water hyacinth in the infested waterways of Badagry, Ejirin and Epe in Lagos State and Iwopin in Ogun State. The larval instars found were damaging only water hyacinth with bulbous petioles. The larval developmental periods ranged between 10-15 days (n = 3).

Key words: *Eichhornia crassipes*, *Niphograpta albiguttalis*, *Neochetina eichhorniae*, *Neochetina bruchi*, Nigeria

INTRODUCTION

Water hyacinth *Eichhorniae crassipes* is one of the fastest growing plants on earth originating in Venezuela and has now spread to at least 50 countries around the world in the tropical and sub-tropical regions including Nigeria.

Water hyacinth first appeared on the waters of the South-Western part of Nigeria in 1984 through the Republic of Benin (Akinyemiju, 1987). Since, then the weed has invaded nearly all inland waters in the Southern part of the country, from low salinity lagoons in Lagos State to fresh water rivers, rivulets and creeks along the coastal areas of Ogun, Ondo, Edo, Delta, Bayelsa, Rivers, Cross River and Akwa Ibom States. The weed has infested >60% of Nigeria's fresh and brackish coastal waters including the Benin and Escravos River networks that are major operational areas for petroleum companies and cause 50% loss of fish catch (Farri and Boroffice, 1999).

In May 1992, the presence of water hyacinth was confirmed on the River Niger in Kebbi State, a border area between the Federal Republic of Nigeria and the Republic of Niger (Kusemijtj *et al*., 1992). By 1995, the weed had spread downstream to the Kainji Lake in Niger State, Jebba Reservoir in Kwara State and River Kaduna threatening the Shiroro Dam. These three dams are Nigeria's main sources of hydroelectric power generation.

However, it is important say that since water is a basic necessity of life and water hyacinth threatens to make it scarce, unavailable or unsuitable even for normal requirements there is a definite need to keep it under check.

From the period of weed invasion the Federal government through the National Agency for Science and Engineering Infrastructure (NASENI) made frantic efforts to control the menace of this weed through, physical removal and herbicides application but recognized that these methods were limited because of non sustainability and high cost: in 1994 alone in Nigeria, 3.5 M₦ was spent on the physical clearing of the River Niger upstream of the Kainji lake, on the average $5000 was spent on manual removal from just 1 ha of infested area (Farri and Boroffice, 1999).

With the problem still unsolved biological control: a long term, cost effective and environmentally friendly method was considered. The following host specific natural enemies which were introduced against water hyacinth with notable successes in many part of the world (Deloach, 1976; Center *et al*., 1982; Harley, 1990) were

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considered: *Neochetina eichhorniae* Warner and *Neochetina bruchi* Hustache (Coleoptera:Curculionidae), *Niphograpta albiguttalis* Warren and *Acigona infusella* Walker (Lepidoptera:Pyralidae).

In May 1992, *Neochetina eichhorniae* was selected and a consignment of 2527 adult weevils was imported from Commonwealth Scientific and Industrial Research Organization (CSIRO), Brisbane, Australia via the Commonwealth Institute for Biological Control (CIBC) quarantine at Silverwood Park, Great Britain for National Horticultural Research Institute (NIHORT), Ibadan where the weevils were mass reared, released and established in Nigerian waterways.

Inadequate and inconsistent funding over the years made monitoring and assessment of establishment ineffective. However, in Oct. 2007, Agricultural Development Bank (ADB) through Federal Ministry of Environment, Housing and Urban Development started collaboration with NIHORT to look into the problem of aquatic invasive weeds in Nigeria.

In Nov. 2008 while on a damage assessment survey of the established *Neochetina eichhorniae* in the infested waterways of Southern Nigeria some larvae were found feeding vigorously on the petioles of water hyacinth, these larvae were collected and reared in laboratory for adult emergence. The emerged adults were identified as *Niphograpta albiguttalis*.

This study therefore, reports the presence and abundance of *Niphograpta albiguttalis* an additional unreleased biological control agent of water hyacinth in some Nigerian waterways and tries to determine the source of this agent in Nigeria.

MATERIALS AND METHODS

The study area: The study was carried out along the rivers, creeks and lagoons of the coastal states of South Western Nigeria which include Lagos, Ogun, Ondo Edo and Delta States. This intricate network of rivers, creeks and lagoons serves as conduits for channeling water from the hinterland to the coast. These waters are used as a means of transportation of goods and people around these coastal areas. The sampled locations within the states are as follows:

- Lagos State: Badagry Oto-Awori, Mile 12, Owode, Odo-Ogun, Itowolu, Majidun, Itoikin, Ejirin and Epe
- Ogun State: Oni, Makun and Iwopin
- Ondo State: Mahin, Ugbonla, Erona, Idogba, Oroto, Igbokoda and Igbekebo
- Edo State: Nikorowa, Ekenwa, Ofunama and Ajakurama
- Delta State: Koko, Ologbo, Ethiope West and Sapele

Collection of samples: Infested areas were located and ten sites were sampled per infested location within the states. Each site was 0.5 km away from another. At each site a quadrant of 0.5 m^2 was thrown and all the plants within the quadrant were collected, placed into plastic bags and processed the same day.

Plants from each site were counted (No. of plants/m^2) and weighed to determine density (kg m^{-2}). All plants from each site were carefully examined for larvae, pupae and adults of other biological control agents apart from *Neochetina eichhoniae* and *N. bruchi*. Each life stage was counted.

Larvae and pupae were taken to the laboratory and reared at room temperature (24-28°C), relative humidity of 79-92% and a 12 h photoperiod. Each larva and pupa was kept in uninfested water hyacinth that were kept in plastic bowl (20 L) till adult emergence and covered with muslin cloth to prevent predation and the escape of adults after emergence. Developmental periods of the larvae till adults were recorded. Emerged adults were separated to species per site.

RESULTS AND DISCUSSION

Apart from the released biological control agents in Nigeria: *Neochetina eichhorniae* (Warren) and *N. bruchi* (Hustache) that are established on the waterways, larvae of *Niphograpta albiguttalis* an unreleased biological control agent was found damaging water hyacinth in the infested waterways of Badagry, 0.2 larvae, Ejirin, 0.1 larvae and Epe, 0.2 larvae in Lagos State and Iwopin, 0.1 larvae in Ogun State, 2 South Western States of Nigeria (Table 1).

Niphograpta albiguttalis larvae were found only in plant with bulbous petioles which had plant no ranging from 1.10-3.35 and plant weight ranging from 0.13-0.56 kg (Table 1). The larvae tunneled petioles and move down to the central rosette of the plant to the rhizome causing petioles and plant to wilt, turn brown and rot. The Laval instars found developed between 10-15 days (n = 3). Fully grown larvae bore hole and an exit in an undamaged petiole and formed cocoon. Pupation occurred within the cocoon. The mean pupal stage was 8 days (n = 3). Adult emerged through the bored exit in the petiole.

About >83% of the total larvae found in the 4 locations of the 2 states were found in Badagry, Ejirin and Epe. All these are in Lagos State, the border State to

Republic of Benin a neighboring country to Nigeria on the West (Fig.1a and b). In all the 28 locations visited, 25 locations had slender petiole water hyacinth infestation while only 10 locations had bulbous petiole water hyacinth which were areas with regrowth (Table 1). The more recent spread and rapid expansion of water hyacinth into many waterways of Africa has caused serious problems. Biological control method being affordable,

Table 1: Number of *Niphograpta albiguttalis* found in surveyed locations per state

			Bulbous petioles			Slender petioles		
Location	Coordinates	State	Mean No. of plants/ location	Mean plants weight/ location (kg)	Mean No. of larvae (*N. albiguttalis*)/ location	Mean No. of plant/ locatn	Mean plants weight/ location (kg)	Mean No. of larvae (*N. albiguttalis*)/ location
Badagry	N06°24'14.812" E002°53'43.056"	Lagos	3.350	0.560	0.200	23.700	4.610	0
Oto-Awori	N06°29'57.952" E003°06'11.449"	Lagos	0.000	0.000	0.000	26.100	4.300	0
Mile 12	N06°36'12.697" E003°24'10.841"	Lagos	0.000	0.000	0.000	6.400	1.700	0
Owode	N06°36'44.884" E003°24'50.192"	Lagos	0.000	0.000	0.000	19.400	3.250	0
Odo-Ogun	N06°36'31.550" E003°26'13.477"	Lagos	2.080	0.230	0.000	21.000	4.100	0
Itowolu	N06°36'47.414" E003°26'32.581"	Lagos	1.700	0.140	0.000	21.300	3.900	0
Majidun	N06°37'08.764" E003°28'09.5863"	Lagos	0.000	0.000	0.000	8.650	2.000	0
Itoikin	N06°39'15.258" E003°47'38.944"	Lagos	0.000	0.000	0.000	18.100	3.800	0
Ejirin	N06°36'42.854" E003°54'03.354"	Lagos	2.900	0.520	0.100	19.200	3.930	0
Epe	N06°34'13.753" E003°59'21.273"	Lagos	2.600	0.490	0.200	22.090	4.540	0
Oni	N06°32'15.257" E004°13'17.671"	Ogun	2.300	0.210	0.000	20.200	3.400	0
Makun	N06°26'21.290" E004°24'37.581"	Ogun	0.000	0.000	0.000	20.800	3.900	0
Iwopin	N06°30'36.421" E004°10'04.221"	Ogun	1.900	0.180	0.100	21.300	3.570	0
Mahin	N06°10'12.350" E004°48'08.099"	Ondo	0.000	0.000	0.000	20.300	3.700	0
Ugbonla	N06°08'11.583" E004°47'12.076"	Ondo	0.000	0.000	0.000	19.500	4.050	0
Erona	N06°07'01.689" E004°46'24.163"	Ondo	0.000	0.000	0.000	17.300	3.750	0
Idogba	N06°06'25.611" E004°46'44.040"	Ondo	0.000	0.000	0.000	20.100	3.730	0
Oroto	N06°04'55.493" E004°48'17.365"	Ondo	0.000	0.000	0.000	0.000	0.000	0
Igbokoda	N06°21'12.802" E004°48'25.943"	Ondo	1.500	0.160	0.000	16.600	3.430	0
Igbekebo	N06°21'12.490" E004°51'36.399"	Ondo	0.000	0.000	0.000	18.000	3.900	0
Nikorowa	N06°15'33.0" E005°22'59.9"	Edo	1.300	0.130	0.000	15.400	2.900	0
Ekenwa	N06°11'28.774" E005°22'06.987"	Edo	1.100	0.130	0.000	17.700	3.000	0
Ofunama	N06°08'857" E005°12'913"	Edo	0.000	0.000	0.000	12.100	2.700	0
Tonjogbene	N06°06'059" E005°14'150"	Edo	0.000	0.000	0.000	12.400	2.500	0
Ologbo	N06°03'06.807" E005°39'50.042"	Edo	0.000	0.000	0.000	4.100	1.300	0
Koko	N05°59'53.926" E005°29'47.116"	Delta	0.000	0.000	0.000	0.000	0.000	0
Ethiope West	N05°51'39.088" E005°43'49.291"	Delta	0.000	0.000	0.000	0.000	0.000	0
Sapele	N05°54'09.513" E005°40'43.627"	Delta	0.000	0.000	0.000	10.300	2.400	0
LSD	-	-	0.362	0.026	0.420	4.042	1.501	0

environmentally friendly and sustainable has been widely considered and given top priority over every other control methods. Beginning in the early 1970's, the USDA and CIBC (now CAB-Bioscience) released the weevils *Neochetina eichhorniae* and *N. bruchi* and later the Pyralid moth *Niphograph albiguttalis* as biological control agents of water hyacinth in infested countries including the following West African countries; Ghana, Benin and Nigeria. Releases were made in 1994, 1991 and 1993 for *N. eichhorniae*, respectively and 1994, 1992 and 1995 for *N. bruchi*, respectively. They both became successfully established in these countries (Julien, 2000).

However, in many situations the control achieved is not been sufficient (Cordo, 1999) and so there is need to release new agents to complement the damage caused by the weevils. This led to the release of a moth *N. albigutallis* in Ghana in 1996 and in Benin in 1993 but this moth did not become successfully established in these countries (Julien, 2000). However, the larvae of this moth found in the waterways of three South Western states in Nigeria in 2009 without release could have been from adults dispersed from Benin the nearest site of release in 1993. This is most likely since, >83% of the total larvae found in the 4 locations of the 2 states were found in Badagry, Ejirin and Epe, locations in Lagos State (Table 2), the border state to Republic of Benin a neighbouring country to Nigeria on the West (Fig. 1b and 2). This is agreeable with the report of Julien (2000) which stated that adult *N. albigutallis* disperse rapidly up to 4 km day^{-1}. Similarly, *N. albiguttalis* was initially released only in Southern Florida but populations

Table 2: Percentage of the total *Niphograpta albiguttalis* larvae per location

Location	State	Percentage of *N. albiguttalis* larvae (%)
Badagry	Lagos	33.33
Ejirin	Lagos	16.67
Epe	Lagos	33.33
Iwopin	Ogun	16.67

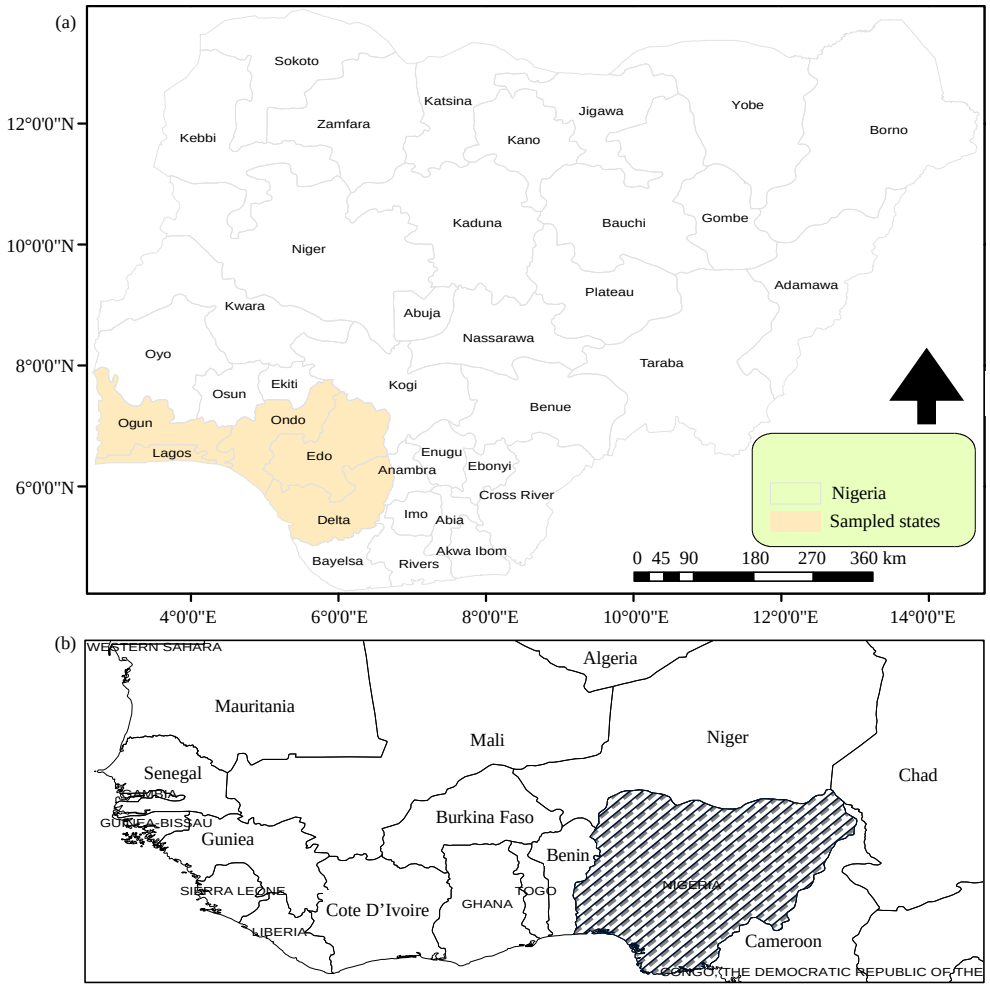

Fig. 1: a) Map of surveyed Southern states of Nigeria and b) Map of West African countries with Nigeria

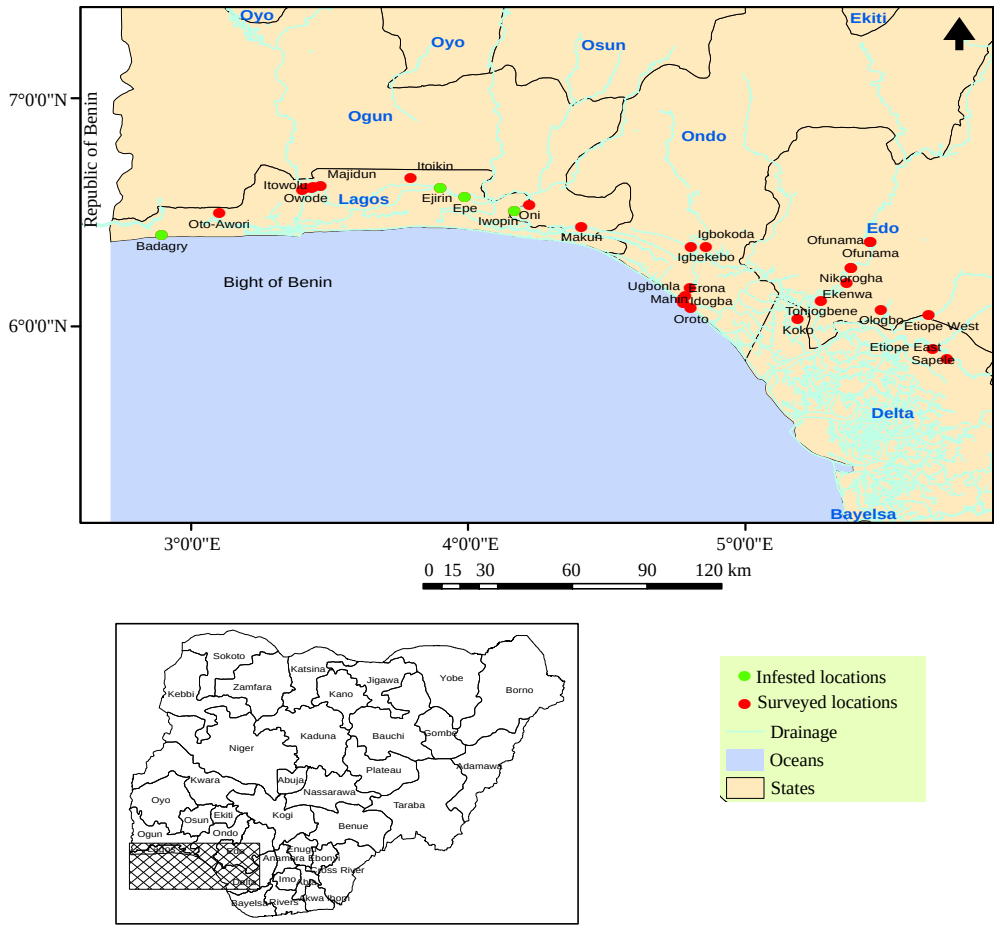

Fig. 2: Map of surveyed and infested locations in Southern Nigeria

dispersed >500 km within 18 months (Center, 1984). This moth was released at two sites in Louisiana during May 1979 and collected 27 km from the nearest release site a year later (Brou). *N. albiguttalis* appeared to be absent from Texas in 1985 and so was released at a few sites during May 1986. It was widely dispersed by July 1986 probably originating from Louisiana rather than the more recent Texas releases.

The range of the larval developmental days of *N. albiguttalis* would have been a little more if the all the larvae found in the field and reared in the laboratory were first instar. The preferential attack of plants with bulbous petioles by *N. albiguttalis* could play an important role in reducing rapidly growing plant that are typical of invasion and regrowth areas (Julien, 2000).

CONCLUSION

The observation of the infested waterways of the 5 infested South Western states revealed the presence of *N. albiguttalis* an additional biological control agent of water hyacinth in two states. Since, there is no record of release of *N. albiguttalis* in Nigeria prior to this time but yet find its way into Nigerian waterways without restriction then it is important that this biological control agent should be imported and post-release evaluations be conducted to determine their safety in Nigeria as biological control.

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