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World Distribution of *Heterobostrychus aequalis* Waterhouse (Coleoptera: Bostrychidae)

Mohd Shahman Md Azmi, Faizah Abood and Norhisham Ahmad Razi

Department of Forest Management, Faculty of Forestry, Universiti Putra Malaysia (UPM), 43400 Serdang, Malaysia

Corresponding Author: Faizah Abood, Department of Forest Management, Faculty of Forestry, Universiti Putra Malaysia (UPM), 43400 Serdang, Selangor, Malaysia Tel: +603-89467192/7198 Fax: +603-89432514

ABSTRACT

Heterobostrychus aequalis is a major pest of seasoned hardwood. It attacks many timber and wood from other plant species and caused damage to a broad range of wood products. Their attacks are confined to starch-rich sapwood and often unsuspected until the emergence hole and frass is produced. The repeated introduction of this pest into new areas indicates that it is poorly inspected and ignored. In some cases, this species succeed in establishing its population in the wild. Hence, by providing the world wide distribution of this pest could be the pioneer step in developing better prevention, monitoring, quarantine and control programmes. From the review, it was found that *H. aequalis* distribute dominantly in tropical and sub-tropical areas. It is widely distributed in Asia, particularly Southeast Asia to Oceania, some parts of Africa, Central America and Caribbean region. The distribution map derived indicates the limits of distribution for *H. aequalis* to be 40° north and south of the equator. The recent reports and records showed that this pest is potentially becoming a high-risk pest and can establish its population whenever the condition is favourable.

Key words: Bostrychidae, distribution, *Heterobostrychus aequalis*, powderpost beetle

INTRODUCTION

Beetles belonging to the family Bostrychidae are amongst the most destructive pest of timber and timber products worldwide. There are about 550 bostrychids species in 99 genera known from all inhabited regions of the world (Ivie, 2002). Bostrychids generally known as powderpost beetles because their larvae reduce the wood into fine flour-like dust known as frass (Ho and Hashim, 1993, 1997; Abood *et al.*, 1994; Liu *et al.*, 2008; Abood, 2008). Powderpost beetles owe their ubiquity largely to their insidious development inside wood in which the medium acts as a buffer to extrinsic fluctuations. Their presence in imported timbers has often been undetected and they are quick to establish populations under suitable conditions (Abood and Murphy, 2006; Abood *et al.*, 2010).

With imminent timber shortages and concerns over depleting forest resources in many countries, intense efforts have been made to maximize utilization of forest resources including lesser known or underutilized species, lower grade timbers and also to encourage a more widespread use of sapwood in timber products (Abood and Murphy, 2006). This includes the using of rubberwood which was known to have high starch content. For example, in Malaysia, rubberwood has emerged as the most important wood raw materials for particle board, medium density fibreboard, parquet

flooring, joinery and furniture production (Zaidon *et al.*, 2007; Loh *et al.*, 2010; Ratnasingam and Ma, 2010; Farrokhpayam *et al.*, 2010). Utilization of such materials which are often has led to greater prominence of powderpost beetle as a pest of seasoned timber and their products.

One of the most common and widespread powderpost beetles in tropical region is *Heterobostrychus aequalis* (Fig. 1a, b). Besides being commonly called powderpost beetles, this species also recognized as 'Oriental wood borer' (Woodruff, 1967; Woodruff and Fasulo, 2006), 'False powderpost beetle' (Jones, 2008) 'Lesser auger beetle' (Anonymous, 2004; Walker, 2008a), 'Trank borer' (Rahman *et al.*, 1995), 'Black borer' (Golob *et al.*, 2002) and 'Kapok borer' (Aguilera, 2006).

Heterobostrychus aequalis breeds in a wide variety of commercial timbers and attack is usually confined to the starch-rich sapwood (Zhenhua and Shuqing, 1992; Ho and Hashim, 1993; Woodruff and Fasulo, 2006). It is a major pest of rubberwood in Malaysia (Hussien, 1981; Ho and Hashim, 1997; Ani *et al.*, 2005; Abood, 2008; Singh *et al.*, 2011) and caused damage to a broad range of wood products such as furniture, plywood, dry poles, toys, tea chests, wooden clogs, carved wood and many samples from wood species collections (Abood, 2008). Some species from *Heterobostrychus* genus even recorded found on cassava, potatoes, coffee beans, oilseeds and pulses (Hill, 2002). This species has a high dispersal potential, wide range of hosts and can contribute to substantial economic losses (Aguilera, 2006; Meissner *et al.*, 2009).

Despite the status as important pest of timber and its products, the information regarding the distribution of this species globally is still scarce and not properly compiled. Therefore, this review was conducted to assemble the distribution check list of this pest and to map the distribution. Various journal articles, reports, online sources, monographs, records etc. globally as early as the year 1914 up to 2010 were reviewed. Several locality of the pest been recorded or intercepted were also included in the list. The presence and occurrence of *Heterobostrychus aequalis* species were assigned as native (N), present (P), intercepted (I), established (E), fail to established (F) and unknown (U).



Fig. 1(a-b): (a) Male *H. aequalis* and (b) Female *H. aequalis*

HETEROBOSTRYCHUS AEQUALIS WORLDWIDE DISTRIBUTION

For any particular pest, when arrived into new destination, they encounter a new environment. Favourable climate, suitable host plant, absence of severe competition and other physical needs such as shelter are needed in order to establish their population (Sutherst, 1991). According to Robinet and Roques (2010) warming can results in removing or relocating the barriers that limit present species ranges and it also likely to facilitate the establishment and spread of invasive alien species. Furthermore, the mobility of good products from one place into another place and human activity may enhance the chances of pest to enter any particular areas.

The ability of Bostrychidae family to attack lumber, wood products and grain has facilitated dissemination of many species through the world (Beiriger and Sites, 1996). According to Ivie (2002), species from this family that attack timber and wood products are now subject to wide distribution over the world. In general, many species of bostrychids are of important in warm temperate and tropical countries (Findlay, 1967; Ebeling, 1975; DeAngelis, 1995; Eaton and Hale, 1993; Jones, 2008).

Heterobostrychus spp. frequently introduced and intercepted in various places all around the world such as in Italy (Ratti, 2002), German (Weidner, 1967; Benker, 2008) France (Henri-Pierre, 2008), USA (Ivie, 2002; Haack and Cavey, 2000; Haack, 2006; Beiriger, 2010), Spain (Anonymous, 2007), New Zealand (Pearson *et al.*, 2006), Belgium (EPPO, 2005) and Canada (Gill *et al.*, 2008) from imported wood and its products. Some species of this genus have already established in new area such as *H. brunneus* in Florida (Ivie, 2002) and California (Peck and Thomas, 1998) while another species which is *H. hamatipennis* became established in Florida (Beiriger, 2010) and Japan (Mito and Uesugi, 2004).

The map derived showed that *Heterobostrychus aequalis* distributed dominantly in tropical and sub-tropical regions within the 40° north and south of the equatorial (Fig. 2). This beetle has been recorded in 6 continents which are Asia, Oceania, Africa, South and North America and Europe. *Heterobostrychus aequalis* were common in Southeast Asian, Indo-China, Indian region, Central America and Caribbean. It has limited distribution in Africa continent and only certain country reported its presence such as Madagascar, Comoros Island, Seychelles Island, Mauritius Island, South Africa and Nigeria while another closely related species to *H. aequalis* which is *H. brunneus* was found to be more dominant and common in Africa (Hickin, 1968; Eaton and Hale, 1993; Robinson, 2005; Walker, 2008b).

Records from literature also showed that *H. aequalis* are able to establish into new regions. For example in Florida (Woodruff, 1967; Halbert *et al.*, 2001; Aguilera, 2006; Woodruff and Fasulo, 2006; Haack, 2006), Venezuela (Aguilera, 2006) and Australia (Heather, 1966). The establishment of *H. aequalis* into new regions indicate that it is a highly potential pest. It shows that this beetle have a great ability to adapt itself into new area. The shipping, trading, export and import activities provide a 'free transportation' for the insect. In addition, the poorly inspected, quarantine and treatment of related wood products contributed directly to the successful of entering and establishment of this species.

In Australia, *H. aequalis* regularly brought through infested timber and wood products mainly from Indo-Malaysian regions (Browne, 1948; Menon, 1957; Heather, 1966; Wylie and Yule, 1977; Creffield and Howick, 1979; Anonymous, 2001; Hadlington and Ion-Staounton, 2008) and established its population in some part of the country which is Queensland, Cape York, Thursday Island and Cairns (Heather, 1966). The post-boarder interceptions of *Heterobostrychus* genus increase in number with increasing volume of Asian furniture and wood related product brought

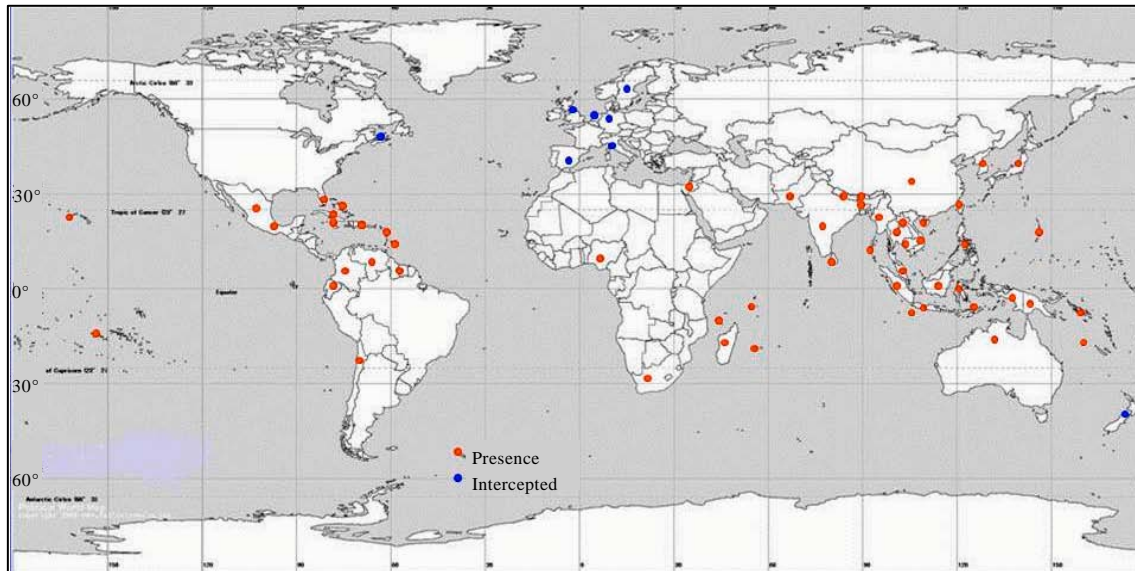


Fig. 2: Distribution map of *Heterobostrychus aequalis* (Coleoptera: Bostrychidae), **Occurrence records of *Heterobostrychus aequalis* : Oceania and Australasian:** Australia, Papua New Guinea, Solomon Island, Guam, Cairns, New Caledonia, New Zealand, Mariana Island, French Polynesia; **Southeast Asia:** Vietnam, Cambodia, Laos, Malaysia, Thailand, Myanmar, Indonesia, East Timor, Philippines **South Asia:** Pakistan, India, Bangladesh, Sri Langka; **East Asia:** Nepal, Bhutan, China, Korea, Taiwan, Japan; **West Asia:** Israel; **Africa:** Comoros Island, Madagascar, Seychelles, Nigeria, South Africa, Mauritius Island; **North America:** Canada, Florida, Hawaii, **Central America and Caribbean:** Cuba, Mexico, Nicaragua, Jamaica, Bahamas, Barbados Island, Trinidad and Tobago; **South America:** Venezuela, Ecuador, Suriname, Colombia, Chile; **Europe:** United Kingdom, Spain, Germany, Sweden, Holland, Italy

into New Zealand (Pearson *et al.*, 2006). Although *H. aequalis* regularly intercept in New Zealand (Archibald and Chalmers, 1983; Anonymous, 2003a) the populations somehow failed to establish probably due to unsuitable climatic conditions.

In North America, particularly USA, *H. aequalis* frequently intercepted in New York, San Francisco, Calif, Dallas, Texas, Allentown, Philadelphia, New Orleans and Los Angeles (Fisher, 1950). The first establishment of this species in Florida were recorded by Woodruff (1967). This species always introduced accidentally to North America particularly Florida in wood products, pellets and containers shipped from the Orient (Tvedten, 1999; Halbert *et al.*, 2001). Majka (2007) reported the interception of *H. aequalis* at Nova Scotia (Canada) but there is no further evidence of the species establishes its population. Meanwhile, in Central America, this beetle occurs in Mexico, Nicaragua and the small country Island surrounding the Caribbean region *viz.* Cuba, Jamaica, Bahamas, Trinidad and Tobago. In South America, the occurrence of *H. aequalis* was recorded in Venezuela, Suriname, Colombia, Ecuador and Chile.

In Europe *H. aequalis* frequently intercepted in Germany (Weidner, 1967; Cymorek, 1970; Benker, 2008) but it is failed to established because of the species is not cold resistance.

Temperature at 17°C and below is said to be unsuitable for the species to breed (Cymorek, 1970). Meanwhile in Italy, *H. aequalis* was intercepted from wood and its products imported from Asian (Gambetta, 1983; Ratti, 2004). *H. aequalis* also reported in Holand, United Kingdom and Sweden. Although this beetle reported in European region, it is doubted that this species could establish in this region as the climate unsuitable for this species. Temperature is undeniably influence the development and fertility of insect (Ahmad *et al.*, 2008). The detail distribution of *H. aequalis* distribution was listed in Table 1.

Table 1: Distribution checklist of *H. aequalis*

Region	Locality	Status	References
Europe			
Germany	Bavaria	I, F	Cymorek (1970), Benker (2008), CABI (2008) and Barriga-Tunon (2009)
Italy	-	I, U	Gambetta (1983), Ratti (2002, 2004), Anonymous (2009a) and Barriga-Tunon (2009)
Holland	-	I, U	Barriga-Tunon (2009) and Buijs (2009)
Sweden	-	I, U	Barriga-Tunon (2009)
Spain	-	I, U	De la Puebla <i>et al.</i> (2007)
United Kingdom	-	I, U	Anonymous (2009a, b) and De la Puebla <i>et al.</i> (2007)
Middle East			
Israel	-	P	CABI (2008) and Barriga-Tunon (2009)
South Asia			
Bhutan	-	P	CABI (2008)
Bangladesh	-	N, P	Rahman <i>et al.</i> (1995), Baksha (2000) and CABI (2008)
India	(Assam, Calicut, Calcutta, Dehra Dun, Tamil Nadu, West Bengal, Uttarakhand, Uttar Pradesh, Punjab, Himachal Pradesh, Madras)	N, P	Stebbing (1914), Beeson and Bhatia (1937), Fisher (1950), Rai and Chatterjee (1964), Woodruff (1967), Gnanaharan <i>et al.</i> (1983), Nair <i>et al.</i> (1983), Mathew (1987), Mathew and Nair (1988), Jose <i>et al.</i> (1989), Zhenhua and Shuqing (1992), Thakur and Bhandari (1997), Krishnasamy <i>et al.</i> (1991), Mathew <i>et al.</i> (2005), Woodruff and Fasulo (2006), Aguilera (2006), De la Puebla <i>et al.</i> (2007), Walker (2008a), Jha and Sen-Sarma (2008), Anonymous (2009a), Sittichaya <i>et al.</i> (2009) and Barriga-Tunon (2009)
Pakistan	-	N, P	CABI (2008)
Nepal	-	P	CABI (2008)
Sri Langka	-	N, P	Holmes (1947), Fisher (1950), Weeraratna (1955), Rai and Chatterjee (1964), Vivekanandan (1964), Woodruff (1967), Tisseverasinghe (1969), Zhenhua and Shuqing (1992), Woodruff and Fasulo (2006), Aguilera (2006), Walker (2008a), CABI (2008) and Barriga-Tunon (2009)
East Asia			
China	(Yunan, Fujian, Hainan, Guangdong)	N, P	Fisher (1950), Zhenhua and Shuqing (1992), Zheng (2005), Aguilera (2006), De la Puebla <i>et al.</i> (2007), CABI (2008), Sittichaya <i>et al.</i> (2009), Anonymous (2009a) and Barriga-Tunon (2009)
Japan	-	I	Zhenhua and Shuqing (1992)
Korea	-	P, I	Anonymous (2006)
Taiwan	-	P, I	Zhenhua and Shuqing (1992), Barriga-Tunon (2009) and Anonymous (2009a)

Table 1: Continued

Region	Locality	Status	References
Southeast Asia			
Vietnam	-	N, P	Booth <i>et al.</i> (1990), De la Puebla <i>et al.</i> (2007), Walker (2008a) and Barriga-Tunon (2009)
Laos	-	N, P	Booth <i>et al.</i> (1990), De la Puebla <i>et al.</i> (2007), Walker (2008a), Anonymous (2009a) and Barriga-Tunon (2009)
Cambodia	-	N, P	Booth <i>et al.</i> (1990), De la Puebla <i>et al.</i> (2007), Walker (2008a) and Barriga-Tunon (2009)
Indonesia	(Irian Jaya, Kalimantan, Nusa Tenggara Sulawesi, Java, Maluku, Sumatra)	N, P	Fisher (1950), Rai and Chatterjee (1964), Kishi <i>et al.</i> (1973), Noerdjito and Suhardjono (1988), Jasni (1990), Zhenhua and Shuqing (1992), Muslich (2004), Jasni <i>et al.</i> (2004), Aini (2005), Woodruff and Fasulo (2006), Aguilera (2006), Sukartana (2008), Walker (2008a), CABI (2008), Sittichaya <i>et al.</i> (2009), Anonymous (2009a, b), Hadi (2009) and Barriga-Tunon (2009)
Malaysia	-	N, P	Fisher (1950), Browne (1948, 1950), Menon (1957), Rai and Chatterjee (1964), Chong-Moi (1975), Dhanarajan (1977), Tan <i>et al.</i> (1979), Hussien (1981), Hong <i>et al.</i> (1982), Norani <i>et al.</i> (1984), Ho and Kirton (1993), Zhenhua and Shuqing (1992), Hong and Sim (1994), Ho (1995a, b), Jenang and Wang-Choon (2001), Ani <i>et al.</i> (2005), Woodruff and Fasulo (2006), Aguilera (2006), De la Puebla <i>et al.</i> (2007), Walker (2008a), CABI (2008), Abood (2008), Barriga-Tunon (2009) and Singh <i>et al.</i> (2011)
Thailand	(Chantaburi, Chiangmai, Chonburi, Chumpron, Nakhon Ratchasima, Phang Nga, Rayong, Samut Songkram, Songkla, Krabi, Satun, Trang)	N, P	Chaiglom (1976), Vongkaluang (1987), Veenin (1992), Hutacharern and Tubtim (1995), Aguilera (2006), De la Puebla <i>et al.</i> (2007), CABI (2008), Sittichaya and Beaver (2009), Sittichaya <i>et al.</i> (2009) and Kangkamanee <i>et al.</i> (2010)
Myanmar	-	N, P	Zhenhua and Shuqing (1992), De la Puebla <i>et al.</i> (2007) and CABI (2008)
Philippines	-	N, P	Fisher (1950), Francia and Garcia (1958), Rai and Chatterjee (1964), Garcia (1976), Bato (1981), Woodruff (1967), Woodruff and Fasulo (2006), Aguilera (2006), De la Puebla <i>et al.</i> (2007), Walker (2008a), CABI (2008) Anonymous (2009a, b) and Barriga-Tunon (2009)
East Timor	-	P	CABI (2008)
Christmas Island	-	P	CABI (2008)
Andaman	-	P	Fisher (1950), Woodruff (1967), Woodruff and Fasulo (2006), CABI (2008) and Barriga-Tunon (2009)
Nicobar Island	-	P	CABI (2008)
Africa			
Comoros	-	P	Ratti (2004), CABI (2008), Anonymous (2009a) and Barriga-Tunon (2009)
Madagascar	-	P	Fisher (1950), Chujo (1958), Rai and Chatterjee (1964), Woodruff (1967), Booth <i>et al.</i> (1990), Zhenhua and Shuqing (1992), Ratti (2004), Robinson (2005), Woodruff and Fasulo (2006), Aguilera (2006), Benker (2008), Walker (2008a), CABI (2008), Sittichaya <i>et al.</i> (2009), Anonymous (2009a) and Barriga-Tunon (2009)
Nigeria	-	P	CABI (2008)
Seychelles	-	P	CABI (2008)
South Africa	-	P	CABI (2008) and Sittichaya <i>et al.</i> (2009)
Mauritius	-	P	Baker (2009)

Table 1: Continued

Region	Locality	Status	References
North America			
USA	Florida	P, E	Woodruff (1967), Halbert <i>et al.</i> (2001), Woodruff and Fasulo (2006), Aguilera (2006), Cabrera (2006), CABI (2008) and Beiriger (2010)
Canada	Nova Scotia	I	Majka (2007), Anonymous (2009a) and Barriga-Tunon (2009)
Hawaii	Midway Atoll	P	Suehiro (1960), Nishida and Beardsley (2002), Barriga-Tunon (2009) and Sittichaya <i>et al.</i> (2009)
Central America and Caribbean			
Cuba	-	P	Woodruff (1967), Woodruff and Fasulo (2006), De la Puebla <i>et al.</i> (2007), Walker (2008a), CABI (2008) and Barriga-Tunon (2009)
Mexico	-	I	Aguilera (2006)
Nicaragua	-	P	Barriga-Tunon (2009)
Jamaica	-	I	Geoghagen (2004)
Bahamas	-	P	Turnbow and Thomas (2008) and Peck (2009)
Barbados	-	P	Peck (2009)
Trinidad and Tobago	-	P	Anonymous (2003b)
South America			
Suriname	-	P	Woodruff (1967), Woodruff and Fasulo (2006), Aguilera (2006), De la Puebla <i>et al.</i> (2007), Walker (2008a), CABI (2008) and Barriga-Tunon (2009)
Venezuela	-	P	Binda and Joly (1991), Sittichaya <i>et al.</i> (2009), Anonymous (2009a) and Barriga-Tunon (2009)
Colombia	-	P	Barriga-Tunon (2009)
Chile	-	P	Chilean NPPO (2007)
Ecuador	-	P	Ecuador NPPO (2008)
Oceania and Australasian			
Australia	New South Wales, Northern Territory, Queensland, Thrusday Island, Cape York	P, E	Heather (1966), Wylie and Yule (1977), Creffield and Howick (1979), Stanaway <i>et al.</i> (2001), Anonymous (2004), Woodruff and Fasulo (2006), De la Puebla <i>et al.</i> (2007), CABI (2008), Sittichaya <i>et al.</i> (2009), Anonymous (2009a, b) and Barriga-Tunon (2009)
Cairns	-	P	Heather (1966)
Guam	-	P	CABI (2008)
Papua New Guinea	-	N, P	Fisher (1950), Beeson (1953), Chujo (1958), Rai and Chatterjee (1964), Woodruff (1967), Gray (1968), Zhenhua and Shuqing (1992), Ratti (2004), Woodruff and Fasulo (2006), De la Puebla <i>et al.</i> (2007), Walker (2008a), CABI (2008), Sittichaya <i>et al.</i> (2009), Anonymous (2009a, b) and Barriga-Tunon (2009)
New Caledonia	-	P	Booth <i>et al.</i> (1990), CABI (2008), Sittichaya <i>et al.</i> (2009), Anonymous (2009a) and Barriga-Tunon (2009)
Mariana Island	-	P	Fisher (1950), Chujo (1958), Woodruff (1967), Woodruff and Fasulo (2006), CABI (2008) and Sittichaya <i>et al.</i> (2009)
Solomon Island	-	P	Booth <i>et al.</i> (1990) and CABI (2008)
New Zealand	-	I	Archibald and Chalmers (1983), Sittichaya <i>et al.</i> (2009), Anonymous (2009a) and Barriga-Tunon (2009)
French Polynesia	Tahiti	P	Nishida (2008)

E: Established, I: Intercepted, N: Native, P: Present, U: Unknown

CONCLUSION

Heterobostrychus aequalis distributes dominantly in tropical and sub-tropical area and restricted to 40° north and south of the equatorial. Evidence showed that this species always introduced to new area via export and import of infested wooden material from their origin country, mainly from the orient. The establishment of this species to new areas suggests that it could become a highly potential pest.

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