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INSECT COLLECTED BY SPRUCE BARK BEETLE PHEROMONE TRAPS IN NORTHERN AFRICA: CASE STUDY IN EGYPT

Master of Sciences

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Statutory declaration

I hereby certify that I have elaborated my thesis independently, only with the expert guidance of my thesis director Jaroslav Holuša, doc. Ing. Ph.D..

I further declare that all data and information I have used in my thesis are stated in the reference.

In Prague ………….   ....……...………………………………….

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ABSTRACT

Ips typographus (Linné, 1758) is one of the most commonly detected pests traveling in solid wood packing material. The field experiments were carried out at two localities, Sharkia and Ismailia Governorates in Egypt. Five Theysohn pheromone slot traps with a cut-off evaporator pheromone lure (IT Ecolure) containing ethanol and cis-verbenol were hanged on trees in both localities in 2012. No specimen of *I. typographus* was collected during this study. Three economically important bark beetles species were found (*Coccotrypes dactyliperda* “Fabricius, 1801”; *Xyleborus saxesenii* “Ratzburg 1837”; *Scolytus amygdali* “Guerin, 1847”). All trapped insects considered as non-target species belong to seven orders. Coleoptera and Lepidoptera orders were more abundant than other orders. 20 Coleopterous species belonging to ten families were attracted in Theysohn slot traps. The most of Coleopterous species are known for Egypt, while five species (*Xyleborus saxesenii* “Ratzburg 1837”; *Metholcus phoenicis* “Fairmaire, 1859”; *Stagetus profunda* “LeConte, 1865”; *Gastrallus corsicu,* “Schislsky, 1898”; *Allandrus interruptus* “Reitter, 1898”) are recorded for the first time in Egypt.

Key word: European Spruce Bark Beetle; survey; pheromone traps; Egypt.

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1. INTRODUCTION

Pine bark beetles are frequent pests of stressed pines, *Pinus* spp., in the southern United States. The five most common southern pine bark beetle species include three from the genus *Ips*: the six-spined ips, *I. calligraphus* (Germar, 1824); the eastern five-spined ips, *I. grandicollis* (Eichhoff, 1868); and the small southern pine engraver, *I. avulsus* (Eichhoff, 1868); and two species of *Dendroctonus*: the southern pine beetle, *Dendroctonus frontalis* (Zimmermann, 1868), and the black turpentine beetle, *D. terebrans* (Olivier, 1795).

Like other pine bark beetles, pine engravers *I. pini* (Say, 1826), live predominantly in the inner bark, where it breeds and feed on phloem tissue. Pines successfully colonized by *Ips* engravers, if not already dead, are killed by adult and larval feeding in the phloem (which can girdle the tree) and by colonization of the sapwood with blue-stain fungi that the beetles introduce. The blue-stain fungi spread into the xylem and block water flow, serving to hasten tree mortality (Connor and Wilkinson, 1983; Kopper *et al*., 2004).

With regard to forest protection, the last decade of the 20th century in Europe was marked by the storms ‘Vivian/Wiebke’ in February/March 1990 and ‘Lothar’ in December 1999. Both events were disastrous and gave rise to an enormous propagation of the European spruce bark beetle (*I. typographus*) in the affected spruce forests (Engesser *et al*., 2002; Flot *et al*., 2002; Schröter *et al*., 2002). The extent of bark beetle damage was huge and large amount of public money was invested in clearing windthrow areas and subsequent sanitation fellings. Consequently, questions concerning the feasibility, efficiency and purpose of traditional phytosanitary measures were raised, triggering intensive research on ecological, economical and phytosanitary aspects of *I. typographus*. There were still considerable gaps in our knowledge of its basic development, biology, behavior and dispersal. In addition, many questions arose concerning the complex interactions between the population dynamics and natural regulation of *I. typographus*, tree susceptibility, and management.

Each of many previous studies or observations on bark beetles in Egypt have been rather limited, besides, caught of new species which have been recorded, therefore the present study is planned in the direction of collecting bark beetles using pheromone traps baited by aggregation pheromone with ethanol and cis-verbenol sited in wood and fruit orchards.

2. REVIEW OF LITERATURE

The review of literature on trees boring by bark beetles belonging to some Coleopterous families with special references to family Scolytidae is included.

European spruce bark beetle, *I. typographus* has caused many problems and economic loss as well as ecosystem change in Europe and Asia. Populations have increased and a possibility of further expansion to North Africa could be exsit with increasing temperature change.

2.1. Geographical distribution and host plants.

EPPO region: Austria, Belgium, Bosnia-Herzegovina, Bulgaria, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Italy (mainly in the north), Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Romania, Russia (northern Russia, central Russia, western Siberia, eastern Siberia, Far East), Slovakia, Slovenia, Sweden, Switzerland, Tajikistan, Turkey, Ukraine, UK (found but not established in Scotland), Yugoslavia. While in Asia: Trans-Palaearctic distribution; occurs throughout northern Asia including China (Heilongjiang), Japan (Hokkaido, Honshu), Korea Democratic People's Republic, Korea Republic, also Georgia, Russia (Siberia, Far East), Tajikistan, Turkey. (Bakke, 1989; Stephen and Gregoire, 2001; Okland and Bjornstad, 2003; Faccoli and Stergulc, 2004; Walker, 2009).

I. typographus is the most serious pest on spruce in Europe. Outbreaks have also occurred in Italy (Lozzia, 1993), Poland, Czech Republic (Pfeffer and Skuhravy, 1995) and in Japan (Hokkaido) in the early 1950 (Inouye and Yamaguchi, 1955; Schwenke, 1996).

2.1.1. Survey and distribution researches of bark beetles in Egypt:

Several species of wood and fruit trees are inhibited in different region of Egypt by a group of bark beetles especially scolytid wood-boring beetles or other boring Coleoptera, which are widely distributed in Egypt (Nour, 1963; Alfieri, 1976; Helal, 1977).

In Egypt Willcocks (1924) mentioned that the Pin hole borer, *Hypothenemus eruditus* (Westwood, 1836) (Scolytidae) occurs in the dead and dying twings and branches of *Sesebania*, and observed that it may also attacks dead wood of various trees in addition to fig and causing "die back" of the ends of twings of the mulberry.

And Hammad (1961) reported *H.eruditus* attacks dead, weakened or even healthy branches of Citrus trees , *Ficus* sp., *Pionciana* sp., *Acacia* sp., *Hibiscus* sp. and *Pitosporum* sp.

Girgis (1987) recorded that the collected scolytids could be arranged descendingly according to their distribution in Egypt and dealt with the host plants such: *Hypothemenmus eruditus*; *H. obscures* (Fabricius 1801); *H. erythrinae* (Eggers 1936), *Xyleborinus saxesenii*, *Scolytis amygdali*, *Hypoborus ficus* (Erichson, 1836). *Phloeotribus scarabaeoides* (Bernard, 1788) in all locations in Egypt except Aswan region.

Alfieri (1976) reported many bark beetles in Egypt, their hosts and locations, Tab. (1):

Table 1. Families and Species of bark beetles in Egypt

Species	**Family**
Scolytus aegyptiacus, Pic, 1920	Scolytidea
Scolytus multistriatus, Marsham, 1802	Scolytidea
Hypoborus ficus, Erichson, 1836	Scolytidea
Trypophloeus granulatus, Ratzeburg, 1837	Scolytidea
Cryphalus eruditus, Hustache, 1836	Scolytidea
Cryphalus(Stephanoderes) vulgaris, Schaufuss, 1897	Scolytidea
Phloeotribus scarabaeoides, Bernard, 1788	Scolytidea
Phloeosinus aubei, Perris, 1855	Scolytidea
Petalium parmatum, Baudi di Selve, 1874	Anobiidae
Mesocoelopus ingibbosus, Pic, 1924	Anobiidae

2.1.2. Means of movement and dispersal

Adults of *Ips* spp. and other bark beetles can fly continuously for several hours. In the field, however, flight has only been observed to take place over limited distances and usually downwind. Beetles have been found in the stomach of trout in lakes situated 35 km from the nearest spruce forest, probably brought by the wind (Nilssen, 1978). Although bark beetles are able to migrate over long distances, the majority of beetles disperse less than 500 meters (Jönsson *et al.*, 2007).

2.1.3. Introduction pathways to new locations

The natural dispersal depends upon the thermal environment and climatic changes, which could facilitate the colonization of higher latitude Norway spruce (*Picea abies*) forests (Seidl *et al*., 2008). *I typographus* is one of the most commonly detected pests traveling on solid wood packing material of bark-associated insects (TNC, 2005). Also, it is capable of dispersing more than several kilometers per year through its own movement or by abiotic factors such as wind, water or vectors by human assisted means, especially via wood products (unprocessed logs or lumber, crating, pallets and dunnage containing bark strips (Eglitis, 2006).

2.1.4. Hosts

Bark beetles attack most of wood of fruit trees all over the world, where *P. abies* is the main host of *I. typographus* in Europe but it infest also other species of *Picea* (e.g. *P. orientalis* “Linné”; *P. jezoensis* “Mayr”; *Abies* spp.; *Larix* spp.; *Pinus* spp.) (CFIA, 2007). In Asia, occasionally breed in species of *Pinus* or *Abies* genera. In Egypt many wood and fruit trees were subjected to bark beetle infestations (Alfieri, 1976).

Chemical communication system is defined as: A complex system of chemical communication governs the host selection process. Male beetles find suitable hosts, probably in response to tree odors, and then initiate attacks. The males produce pheromones, which aggregate both sexes to the host tree. Once the host is fully colonized, the beetles produce anti-aggregant chemicals, which lead to cessation of further attacks. Male beetles are the principal producers of these chemicals, which are derived from host monoterpenes (Eglitis, 2006). This species possesses two important traits that are characteristic of aggressive species of bark beetles: effective aggregation pheremones and vectored mutualistic fungi that may help to overcome tree defenses (Vite *et al*., 1972; Grodzki *et al*., 2004).

2.2. Ecological studies of bark beetles:

Williams and Liebhold (2002) reported that, one expected effect of global climate change on insect populations is a shift in geographical distributions toward higher latitudes and higher elevations. Southern pine beetle *D. frontalis* and mountain pine beetle *D. ponderosae* (Hopkins, 1902) undergo regional outbreaks that result in large-scale disturbances to pine forests in the south-eastern and western United States, respectively. Also, the outbreak areas for southern pine beetle increased with higher temperatures and generally shifted northward, as did the distributions of the southern pine forests. And outbreak areas for mountain pine beetle decreased with increasing temperature and shifted toward higher elevation. That trend was mirrored in the projected distributions of pine forests in the region of the western U.S. encompassed by the study.

Grunwald (1986) reported that in two stands of spruce in northern Germany colonization patterns of seven species of bark beetles were examined under field conditions. It can be shown that all species are segregated from each other by means of only a few factors. Which are the stand-specific microclimate, cover of logs with soil, bark thickness, and body size of beetles. Particularly the relation between tree height and minimal bark thickness is pointed out. The lower limit of thickness of bark which can be colonized by *I. typographus* is 2.5 mm.

(Bakke, 1968) recorded that, the species (*Blastophagus piniperda* “Eichoff, 1864”; *B. minor* “Mader, 1937”; *Ips sexdentatus* “Boerner, 1767”; *I. acuminatus* “Gyllenhal, 1827”) giving results of field and laboratory studies of: their geographical distribution; the frequency of their occurrence in felled Pine trees (also gives data on *Pityogenes quadridens* “Hartig, 1834”; *Orthotomicus proximus* “Eichhoff, 1868”). Flight period (flight in relation to temperature, diurnal flight pattern, sex ratio during the flight period, difference between species, and relation between flight period and entry into the wood). Temperature preferences for gallery construction; brood development (in the laboratory at constant temperatures, and in field investigations in relation to bark temperatures); and temperatures in the environment of hibernating beetles, and the cold hardiness of species and stages.

Martikainen *et al*., (1999) reported that compared the assemblages of bark beetles and associated beetle species among mature and overmature managed, and old-growth *P. abies* dominated mesic forests in southern Finland. They established 10, 11 and 9 sample plots in these categories, respectively, within an area of 35 × 80 km. They took the beetle samples by 10 window-flight traps in each 1 ha plot (total number of traps = 300). The species richness of bark beetles was highest in old-growth, lowest in mature, and intermediate in overmature forests. This was due to the greater amount and diversity of decaying wood in old-growth forests. Bark beetles which are dependent on deciduous trees, especially *Trypodendron signatum* (Fabricius, 1787), were significantly more abundant in old-growth than in mature forests, obviously because deciduous trees have decreased in managed forests. The overall abundance of bark beetles was 23% higher in overmature and 30% higher in old-growth than in mature forests, but the differences were not statistically significant.

2.3. General studies on attractants

2.3.1. Ethanol as an attractant material to the bark beetles

Forst and Dietrich (1929) stated that, the traps baited with fermentation molasses solution captured 11 species of bark and ambrosia beetles. While (Buchanan, 1941) stated that, the injection of elm trees with 50% ethanol obtained heavy attack by scolytid *Xylosandrus germanus* (Blandford, 1894) on treated section while untreated elm sections were not attacked.

Browne (1952) revealed that, immediate and heavy attacks were obtained by several species of ambrosia beetles on trees treated with ethanol (root injection of a living trees and immersion of the butt end of a freshly out sopling).

Norris and Barker (1969) determined that, ethanol is a tunneling (feeding) stimulant for *Xyleborus ferrugineus* (Fabricius, 1801) in artificial media.

Cade *et al.* (1970) stated that the odors emanating from dead or dying trees are known to be essential in guiding ambrosia beetles to their hosts. They tested the response of the scolytid *Gnathotrichus sulcatus* (LeConte, 1868) by using ethanol 82%, 50% plus 4 days old hemlock logs, soaked logs, nonsoaked logs and water as a control. The results indicated that ethanol was a primary attractant for *G. sulcatus*.

Gil *et al*., (1985) in Spain, studied the Coleoptera especially the scolytids attacking coniferous namely *Pinus sylvestris* (Linnaeus, 1754), *P. pinaster* (Aiton, 1789), *P. pinea* (Linnaeus, 1753) and *P. halepensis* (Miller, 1768). Particular attention was paid to the chemicals that attract the beetles to initiate on attack. Five potential attractants were tested, (logs of *P. sylvestris* both thin barked and basal parts with corky bark), twigs, ethanol, paintes logs and logs under black cover. The logs and twigs exercised both visual and olfactory attraction, while ethanol and covered logs provided only chemical attraction. The evidence showed that the chemical stimuli from potential breeding materials guide the insects, the visual attraction playing an important role in recognition of the trophic environment.

Klimetzek *et al*. (1986) studied the effect of ethanol concentration on the reponse of scolytids *I. typographus, Xyleborinus saxesenii, Xyleborus dispar* (Fabricius, 1792), *Xylosandrus germanus, Hylurgops palliatus* (Gyllenhal, 1813) and *Tomicus piniperda* (Linnaeus, 1758). They showed that the response of all *Xyleborus* and *H. palliatus* increase in ethanol concentration and the different of ethanol to the pheromone of *I. typographus* led to the reduction of the response at all concentrations.

2.3.2. Traps logs as an attractant to bark beetles

Russo (1931) in Sicity, indicated that, the adult of *Scolytus amygdali* occur more or less continuously from April to September. He showed that for control *S. amygdali,* infested material and all withered or withering twigs and branches should be destroyed, and branches attractive to the beetles placed in tree as traps.

Charles (1936) in U.S.A. stated that *Scolytus multistiatus* and *Hylurgopinus rufipes* trap logs have been used in forestry as means of reducing bark beetle populations. They would be useful in number of ways in the control of these pests, and also other beetles infesting elm bark. Further, to offer an accessory means of reducing beetle populations in an area, to scout an area for the presence of beetles, to determine the status of beetle populations from year to year. The same author revealed that, the seasonsaly data for the main cutting showed that the infestation for April and May cut logs was very low after these cutting it increased, with the exception of that of July 14, until the maximum average infestation of 19.9 *Scolytus* galleries per log was reached in August 1, cut of logs after this time the number of galleries per log decreased until, but 2 galleries per log was found in September.

Graham and Werner (1956) as well as Chapman (1962) and (1963) have advanced evidence that a principal factor in the susceptibility of logs to attack by ambrosia beetles is a volatile chemical which serves as a guiding cue to the insect.

Chapman (1962) in Canada stated that, the attack flight behavior of ambrosia beetle *Trypodendron lineatum* (Olivier, 1795) lead to the concolusion that beetles are guided to attack by odors from logs. He indicated also that when searching for logs, beetles fly against the wind until they are near a source of attraction abd then continue their search by crawling.

Chapman (1963) showed that air from a common source was divided and each portion blown through separate large box containing, except for an empty control, logs from one tree species, air from each box was conducted a way on released between two window flight traps. Four coniferous tree species were represented in the test bark and ambrosia beetles from natural populations responded positively to log odours in the released air. He also stated that there were differences in the response of beetle species to the log odours represented.

Russo (1963) in Italy mentioned that, for control of *Phloeotribus scarabaeoides*, freshly cut tree should be left in the field to attract ovipositing female and dusted after 2 – 3 days with DDT, Aldrin and BHC (pesticicdes). Secondary attraction caused by the establishment of the first beetles on the trees consisting of pheromone, excreta and the chemical changes in the tree tissues, caused by their exposure, through beetle damage to air. The impact of microorganisms are also important.

Weslien (1984) in Sweden compared differences between tube traps with modernized version of the old traps tree method by synthetic pheromone dispensers attacked to each tree in part of a presumably threatened stands. When these trees are completely attacked (this usually takes 2 – 3 days) they are felled and immediately transported a way. The pheromone dispensers are then shifted to another group of trees. Comparative counts of beetles catches indicated that numbers caught were many times those obtained with traps and that towards the end of the operation, the standing traps trees were much less attacked.

2.3.3. The pheromone system of *I. typographus*

I. typographus volatile substances from the host tree may guide the beetles to areas containing breeding materials. The major components of the aggregation pheromone released by the boring male are (S)-cis-verbenol and 2-methyl-3-buten-2-ol. Ipsdienol, is shared by the most of *Ips* spp., but seems to play a minor role (Bakke *et al*., 1977; Birgersson *et al*., 1984; Schlyter *et al*., 1987).

Two components inhibit the response to the aggregation pheromone, and act as an anti-aggregation pheromone. These are verbenol and ipsenol (Bakke, 1981). They are released when females have entered the gallery and seem to regulate gallery density and cause the shift to boring in new bark areas or in neighbouring trees. During non-outbreak periods, the beetles breed in wind-felled trees, slash and logs. During outbreaks the beetles are able to kill even healthy trees (Schwerdtfeger, 1955; Thalenhorst, 1958; Svihra, 1973). There are two reasons for this ability. The beetle has an effective aggregation pheromone and also carries a load of spores of several blue-stain fungi which contaminate the phloem and cambium and play an active role in killing the tree (Christiansen and Horntvedt, 1983).

Parent beetles may leave successfully attacked host trees after a short period of time to produce a second, sister brood in other trees. Parents re-emerge sooner when gallery density is high (Anderbrant, 1986). Whereas only one annual generation is produced at high altitudes and latitudes, the species has generally two generations in the lowlands of central Europe and even three generations per year at warmer sites. The flight for the second generation generally takes place in July/August. In northern areas, beetles of the new generation emerge from July to October, depending on time of brood establishment, microclimate and weather. In central Europe emergence of the second generation may take place as late as November.

The beetles generally hibernate in the adult stage, mainly in the forest litter, close to the tree where they developed. They may also overwinter under the bark of the host tree. Larvae and pupae have supercooling points of -13 and -17°C, respectively, while adults can tolerate winter temperatures close to -30°C (Annila, 1969).

I. typographus developed an effective chemical signal system by which to coordinate the attack and to aggregate in masses on selected trees (Bakke *et al.* 1977; Schlyter *et al*., 1987). When the male beetle initiates the boring in the bark of trees, it produces a pheromone which attracts female and other males. Two components occur when the females have entered the gallery. These are ipsenol and verbenone, which inhibit response to the aggregation pheromone and act as an antiaggregation pheromone (Bakke 1981).

2.4. Flight activity

Diurnal flight activity occurs from approximately 9 a.m. to 9 p.m. with maximum at noontime and in the early afternoon (Funke and Petershagen, 1991). Obviously, this depends on the temperature. Minimum air temperature for flight was 16.5 °C, and optimum temperature between 22 °C and 26 °C. This may be important for optimizing water use in sprinkled log storage systems. Swarming depended greatly on sunshine. Even with short sunbursts, more *I. typographus* beetles took flight than during periods without sunshine (Lobinger and Skatulla, 1996). Flight activity had an upper threshold of 30 °C (Lobinger, 1994). Males emerged earlier than females (Zuber and Benz, 1992). This makes sense since pioneer males have to find and colonize susceptible trees and excavate the nuptial chambers before females can reproduce.

Studies in the Bavarian Forest have confirmed that, for a successful attack on living trees in spring, at least three to four warm days in a row are needed with temperatures well above the swarming threshold (Weissbacher, 1999).

2.5. Pheromone biology

Persson *et al*. (1996) as well as Wajs *et al*. (2006) studied on *I. typographus* to investigate the peripheral coding of bark beetle pheromones and odors associated with host (conifer) and non-host (angiosperm) plants. They primarily includes compounds with known behavioral effects, but since only a few host odors have been conclusively shown to influence the behavior of *I. typographus*, they also includes major spruce monoterpenes. Bark beetle produced compounds, host (conifer), and non-host (angiosperm) compounds respectively, using comparable numbers of compounds from these three semiochemical classes.

It is known that the aggregation pheromones of *I. typographus* consist of terpenoids that are biosynthesized from tree resin components. These intraspecific semiochemicals are much more attractive than the volatiles (kairomones) emitted by the spruce trees. Conspecific bark beetles are attracted by aggregation pheromones when a suitable breeding substrate is available. However, there is also evidence that *I. typographus* produces repellent pheromones where the substrate is unsuitable for breeding (Francke *et al*., 1995). Traps baited with both the commercial lure Pheroprax® and the anti-aggregation pheromone verbenone or the tree volatile (+)-alpha-pinene caught only 2–30% of the number of beetles caught in traps baited exclusively with Pheroprax® (Zhang *et al*., 1999). While the pinene component also prevented trees from being attacked, verbenone did not. The attractiveness of a vital spruce tree, which is low per se, is distinctly higher when a pheromone dispenser is attached (Franklin and Gregoire, 1999).

Earlier work has already shown that the energy reserves of *I. typographus* beetles need to be depleted before the beetles will respond to pheromones (Gries, 1985). Likewise, (Nemec *et al*., 1993) found that beetles which were responding to pheromone had a higher body weight than those attracted to the lure. The beetles attracted to the pheromone traps differed in glycogen (representing reserves) and protein (representing flight muscles) levels, 30% of them had high glycogen and low protein levels and were hypothesized to originate from local populations and 70% were assumed to be migrants (high protein levels).

Other primary scolytids have been found to produce aggregation pheromones only until the moment when the host resistance threshold was reached (expressed in attacks per unit area), i.e. as long as the host's resin system remained active (Paine *et al.*, 1997).

2.6. Pheromone production in bark beetles

The first aggregation pheromone components from bark beetles were identified in 1966 as a mixture of ipsdienol, ipsenol and verbenol. Since then, a number of additional components have been identified as both aggregation and anti-aggregation pheromones, many of them are monoterpenoids or derivates of monoterpenoids. The structural similarity of the major pheromone components of bark beetles and the monoterpenes found in the host trees, along with the association of monoterpenoid production with plant tissue, led to the paradigm that most if not all bark beetle pheromone components were derived from host tree precursors, often with a simple hydroxylation producing the pheromone. In the 1990s there was a paradigm shift as evidence for de novo biosynthesis of pheromone components began to accumulate, and it is now recognized that most bark beetle monoterpenoid aggregation pheromone components are biosynthesized de novo. The bark beetle aggregation pheromones are released from the frass, which is consistent with the isoprenoid aggregation pheromones, including ipsdienol, ipsenol and frontalin, being produced in midgut tissue. It appears that exo-brevocomin is produced de novo in fat body tissue, and that verbenol, verbenone and verbenene are produced from dietary αpinene in fat body tissue. Combined biochemical, molecular and functional genomics studies in *Ips pini* yielded the discovery and characterization of the enzymes that convert mevalonate pathway intermediates to pheromone components, including a novel bifunctional geranyl diphosphate synthase/myrcene synthase, a cytochrome P450 that hydroxylates myrcene to ipsdienol, and an oxidoreductase that interconverts ipsdienol and ipsdienone to achieve the appropriate stereochemistry of ipsdienol for pheromonal activity. Furthermore, the regulation of these genes and their corresponding enzymes proved complex and diverse in different species. Mevalonate pathway genes in pheromone producing male *I. pini* have much higher basal levels than in females, and feeding induces their expression. In *I. duplicatus* and *I. pini*, juvenile hormone III (JH III) induces pheromone production in the absence of feeding, whereas in *I. paraconfusus* and *I. confusus*, topically applied JH III does not induce pheromone production. In all four species, feeding induces pheromone production. While many of the details of pheromone production, including the site of synthesis, pathways and knowledge of the enzymes involved are known for *Ips,* less is known about pheromone production in *Dendroctonus*. Functional genomics studies are under way in *D. ponderosae,* which should rapidly increase our understanding of pheromone production in this genus. This chapter presents a historical development of what is known about pheromone production in bark beetles, emphasizes the genomic and post-genomic work in *I. pini* and points out areas where research is needed to obtain a more complete understanding of pheromone production (Blomquist *et al*., 2010).

2.7. Dispersal

Dispersal is tightly connected to the response of the beetles to pheromones. Several authors have performed mark-recapture experiments to estimate the dispersal and flying distance of bark beetles after emergence. This involves marking the beetles, releasing them and recapturing them in traps. Usually, only a small proportion of the released beetles are recaptured. In Sweden, (Weslien and Lindelöw, 1990) caught 8 % of the released beetles in pheromone traps at a distance of 100 m, and 2% at 1200–1600 m. They employed pipe traps with Ipslure®, while in Central Europe slot traps with Pheroprax® are commonly used. Similar recapture rates at the above distances from the release point were reported by (Zumr, 1992; Duelli *et al*., 1997). Re-emerged parental beetles (seeking facilities to produce sister broods) seem to travel less far (Zolubas and Byers, 1995). From the recapture data several authors have calculated diffusion curves in the form of power or exponential functions. Using such equations and based on an attraction radius of a pheromone trap of 17–34 m (Schlyter, 1992), a trap at 25 m distance from an infested tree would catch from 20% to 54% (Weslien and Lindelöw, 1990; Duelli *et al*., 1997) of the local population. However, these percentages relate to the total number of recaptured beetles. If the catches reported by (Duelli *et al*., 1997) are related to the total number of released beetles (both recaptured and non-recaptured) only 26% of the beetles are caught at this distance. In traps at 5 m from the release point, 35% of the marked beetles were trapped (Duelli *et al*., 1997). Therefore, it seems that at most a third of the local population may react to pheromones immediately after emergence, while the remainder travels farther. More than 50% are thought to fly further than 500 m. Further evidence of this is the fact that thousands of unmarked *I. typographus* were caught in a pine forest 6 km away from the nearest spruce stand. In a bivoltine situation, the overwintering generation was found to disperse more extensively than the summer generation (Furuta *et al*., 1996).

The flight paths of *I. typographus* beetles, their dispersal, and their reaction to pheromone traps have been modeled in computer simulations by (Byers, 1993; 1996; 1999; 2000).

Duelli *et al*. (1997) reported about the migration in spruce bark beetles *I. typographus* and the efficiency of pheromone traps who found that mark-release-recapture experiments with both newly emerged and flight experienced *I. typographus* were performed in a pine forest near Prague. Three concentric trap circles around the release site with a radius of 5 m, 200 m and 500 m, and intertrap distances of 6 m, 16 m and. maximally, 40 m, were installed with the intention of collecting all dispersing bark beetles ready to respond to pheromone lures. The results show that even without wind and no potential host trees in the surroundings, only about one-third (35.4 %) of the emerging beetles in an infested site can be eliminated locally with phermomone traps. At least 12.2 % of the emerging beetles (25.7 % of the recaptures), perform an adaptive migration flight, which brings them beyond the range of local pheromone traps. The estimated proportion of emigrants can rise over 50%, if most of the freshly emerged beetles that have never been recaptured are assumed to have left the experimental area. Electroantennograms recorded in the laboratory at different times after emergence indicate that the delayed response to aggregation pheromones in migrating bark beetles is not the result of a delayed maturation of the antennal receptor cells, but obviously governed by the central nervous system. The notion of precopulatory migration in 25–50 % of the individuals in an *I. typographus* population can explain why pheromone traps can never eliminate all emerging beetles, and why so many bark beetles can be collected far away from any breeding sites.

2.8. Susceptibility of trees

Bark anatomy and the physiological condition of a potential host tree are crucial for the success of a bark beetle attack. Vital trees possess defense mechanisms at several levels to prevent attacking bark beetles from successfully establishing broods. These mechanisms have been studied in detail under field and laboratory conditions (Baier, 1996; Rohde *et al.*, 1996; Lieutier *et al.*, 1997). The first level of defense is when stored resin is released upon attempted penetrations of the bark. This is referred to as primary, preformed or constitutional resistance (Paine *et al*., 1997). Spruces with thick bark and dense resin ducts seem to be more efficient in repelling boring attempts than thin-barked, low resin trees (Baier, 1996; Wermelinger, 2004). Trees in mixed stands had a higher primary resin flow than those in pure spruce stands (Baier *et al*., 2002). When the preformed resistance is exhausted, it is superseded by induced resistance mechanisms. This second level of a tree's defenses involves a change in the local metabolism around the entrance hole. Defensive chemicals such as procyanidine are produced, which impair the food quality and hence the establishment of a brood (Rohde *et al.*, 1996). The third defense level is a systemic change in the whole tree metabolism. This leads to the production of fewer carbohydrates but more proteins, which are needed for defense. This deterioration in nutrition quality interferes with the establishment of other beetle broods. In the last defense phase, when attack densities are high, a wound reaction sets in where periderm tissue and resin ducts are newly formed. Successful bark beetle establishment is therefore considered to occur in two successive steps, i.e. first the tree's defenses are exhausted by pioneer beetles and second, final colonization of the tree occurs (Lieutier, 2002).

Trees with a medium relative sapwood growth allow more successful broods than trees with high or low growth (Baier, 1996). Similarly, beetles breeding in trees with intermediate crown density appear to produce more progeny than beetles in trees with other crown densities (Mattanovich *et al.*, 2001). In the latter study, breeding success could be related to several plant compounds such as sulfates, proteins and C/N ratio. (Brignolas *et al*., 1998) found the phenolic composition of the phloem could be used as a measure of tree resistance. The cortical terpene pattern did not change between felling and colonization by *I. typographus* (Führer *et al*., 1992).

2.9. Trapping

Pheromone traps are used as surrogates for trap trees. A key component of the pheromone lures is cis-verbenol (Jakus and Blazenec, 2002). The number of bark beetles caught in pheromone traps highly depends on environmental and local conditions, such as temperature, exposition, sun exposure, and competition from nearby woody debris, slash, log stacks, windthrows, and susceptible trees (Lobinger, 1995). Traps exposed to the south, for example, were found to catch four times more *I. typographus* than those exposed to the north (Lobinger and Skatulla, 1996). Yearly catches could be correlated with the previous year's temperatures in May and June (Bakke, 1992). Most authors question the efficiency of pheromone traps as a measure for reducing bark beetle populations (Dimitri *et al.*, 1992; Wichmann and Ravn, 2001). It has been calculated that only up to 10% of a population are caught with high trap densities (Weslien and Lindelöw, 1990). In one study 24 traps per hectare caught only an estimated 3% of the population (Lobinger and Skatulla, 1996). A total of 270,000 traps were used during an outbreak in a Swedish province, but the breakdown of *I. typographus* in the early 80's was not attributed to this measure (Weslien, 1992). (Wichmann and Ravn, 2001) found no correlation between trap catches and the density of tree attack around the traps, in contrast to earlier findings by (Weslien *et al*., 1989). High trap catches did not necessarily correlate with high infestations, but low catches usually meant that little damage would occur (Weslien, 1992; Lindelöw and Schroeder, 2001).

Traps are more often used to prevent attacks on living trees than to diminish *I. typographus* populations. This approach is often regarded a reasonable protection measure (Jakus, 2001), although it involves considerable effort (Dimitri *et al*., 1992; Jakus, 1998). (Jakus, 1998) reported that an infestation front came to a standstill after one year when a two-row barrier of pheromone traps was used. Unfortunately, there was no simultaneous control treatment in this study. Trap trees, which were used more often before pheromones became commercially available, proved to be up to 14 times more efficient in trapping beetles than artificial traps (Drumont *et al*., 1992). In Belgium living trap trees baited with pheromones and treated with insecticides are still common. This kind of trap tree caught up to 30 times more beetles than the widespread Theyson® trap (Raty *et al*., 1995), especially when the bait was protected from the sun. Extensive application of trap trees has also been reported to protect windfalls, with the number of trap trees being dependent on the previous year's number of attacked trees (Grégoire *et al*., 1997).

Weslien and Bylund (1988) The influence of season, and pheromone release rate on the number and sex of *I. typographus* caught in flight- (barrier), landing- (sticky), and entering- (pipe) traps were investigated in the field. During the first 6 days of flight in spring the proportion of males among beetles caught flying around, landing on, and entering pheromone-baited pipe traps was estimated to be 41%, 29% and 18% respectively. During this period the proportion of males among beetles caught decreased with time by a ca 20% in all three trap types. The first flight period was probably the time during which most beetles left their hibernation sites. Thereafter the sex ratio was constant over time, corresponding to ca 30% males among beetles caught on the landing traps. All three trap types caught more females at a high release rate of pheromone than at a low release rate. Although the catch of males was higher in the flight traps at the high release rate, there was no effect of release rate on male catch in landing traps and entering traps. The results are discussed in contexts of beetle behaviour, trap technology, and forest protection.

Sanders (1984) In the open air newly emerged beetles showed a very different flight capability. The initial flight was directed by optical structures next to the starting place. The number of caught beetles in pheromone baited traps showed that in the endemic phase the summer generation of *I. typographus* extended the dispersal flight to deciduous stands. Relative high numbers of beetles were counted in traps on the southern edge of a beech stand at a distance of at least 400 m from the next potential breeding place. Within the beech stand beetles were caught but in a significant smaller number as on the edge.

Nilssen (1984) Trap logs of spruce (*Picea abies*) were placed at different distances north of the spruce forests along the Muonio-Kilpisjarvi road in northwestern Finland. At the greatest distance, 171 km (Kilpisjarvi), 3 scolytids were found: *Dryocoetes autographus*, *Hylastes cunicularius* and *H. brunneus*, and the Curculionid *Hylobius abietis*. These were evidently dispersed anemochorously from the Finnish/Swedish forests. At the other sites spruce bark beetles were found at the following maximum distances from the spruce forests: *Pityogenes chalcographus* and *H. cunicularius*: 86 km, *D. autographus*: 52 km, *I. typographus*: 43 km (trap log baited with synthetic pheromones), *Hylurgops glabratus*: 19 km, and *D. hectographus*: 10 km. Some of the species may have originated from small populations living on nearby non-host trees *Pinus sylvestris*, but most of them were probably blown by winds or actively flew from the spruce forests.

Forsse and Solbreck (1985) Migration by flight is important for the bark beetle *I. typographus* L. because its normal breeding habitats are ephemeral and scattered. Flight during was recorded on flight altitude measured with suction traps on a TV tower. There is much variation in flight duration between individuals which apparently is not an artifact of the method and which is unrelated to sex, size and environmental conditions earlier in the life of the beetle. The timing of flight is affected by recent environmental conditions. Roughly 10% of the population flies above the forest canopy and have the possibility of travelling considerable distances with winds. The major part of the population seems to fly within the forest (below tree tops), but nevertheless seems able to search large areas during extended and repeated flights over several days.

Duelli *et al.* (1986) Flight phenologies and vertical distribution of bark beetle flight were investigated in an agricultural area at least 420 m way from potential breeding places. Pheromone traps (Pheroprax, Linoprax) and unscented sticky traps (square grids of 1 m2) were fixed on a meterological mast at 9 different heights from 1.7 m up to 150 m. Of the 12 scolytid species recorded in 1984, *I. typographus* L. (N = 287) and *Pityogenes chalcographus* L. (N = 319) were the two most abundant species. The vertical flight distribution of *I. typographus* shows a marked peak at 5 m. Less than 5% flew higher than 10 m, with 1 individual at 100 m. More females than males were caught in the pheromone traps. Maximum catches of *P. chalcographus* were at the lowest level, at 1.7 m. Decrease in numbers with height is slower than in *I. typographus*; 14% flew higher than 10 m. In the pheromone traps, 82% were males. In the sticky traps, the sex ratios of both species were more balanced. The phenologies of both *I. typographus* and *P. chalcographus* show two peak flight periods. Flight in May/June respresents the overwintered generation, July/August presumably the summer generation. A comparison with reference traps within forest area 700 m north and south of the meteo mast reveals that the proportion of *I. typographus* flying out of forest areas varies greatly between the two generations while less than 10% of the overwintered beetles were trapped outside of the forest, more than a third of the summer catches were trapped far away form any potential breeding places. It is suggested that habitat changes (innerforest movements) are mainly performed by the summer generation, while the overwintered beetles are less mobile. From March to September, *Trypodendron lineatum* was abundant in forest areas, but virtually absent in our traps outside the forest, suggesting a far less dispersive flight behavior.

Traps baited with the commercial population attractants Pheroprax and Chalcoprax, developed to attract the eight-toothed spruce bark beetle, *I. typographus* L., and the six-toothed spruce bark beetle, *Pityogenes chalcographus* (L.), respectively were used in 1988-1990 to study the flight activity of these insects and their attraction by the preparations. During the three years of investigations, the dates of emergence and the peaks of the first and the second flight remained almost unchanged. Whereas the Chalcoprax-baited traps captured almost only individuals of *P. chalcographus*, the traps baited with Pheroprax attracted mainly *I. typographus* but also a fair number of *P. chalcographus*. On the average, 60-75% of the P. chalcographus specimens caught by the traps baited with Chalcoprax were females, whereas their percentage in the Pheroprax-baited traps was 20-30% only. Both of these polygamous bark beetles when captured in the traps baited with the corresponding specific attractants exhibited a remarkable predominance of males (50-65%) at the beginning of the first flight period, but this percentage dropped to 25-35% after 2-3 weeks. However, the predominance of the males of *P. chalcographus* captured in Pheroprax-traps either remained high (65-90%) or did not develop below 60% (except in July 1990). It was shown that the distance of Chalcoprax-baited traps from the Pheroprax-baited traps could influence the number and the sex-ratio of *P. chalcographus* in the Pheroprax-baited traps, the number being increased in the presence of Chalcoprax. The potential components responsible for attraction of the males in the traps baited with Chalcoprax or Pheroprax are suggested (Zuber and Benz, 1992).

Flight activity of the spruce bark beetle, *I. typographus* L., was monitored from 1979-1981 in spruce stands 460-600 m a.s.l. (above sea level) in southern Bohemia (Czechoslovakia), by means of Pheroprax pheromone traps. The number of males decreases and the number of females increases as the season advances. The prevalence of females flying to the traps is coincident with the swarminng peak; females made up 58.5% of the total number of attracted beetles. Subsequent to swarming flights (= attacks) of the 1st generation and beginning of swarming caught after the swarming-peak partly deposited their eggs and represented 3.8-28.6% of the total number of collected females (Zumr, 1982).

In spruce strands situated in the area of South Bohemia trials were performed concerning the migration of marked adults of spruce bark beetle. In total 44 pheromone traps were used for investigations, placed in circles at distances of 400, 800 and 1200 m. In the spring season 77.0% of individuals of spruce bark beetle were caught out of the total number of marked spruce bark beetles which were let fly. The highest entrapment was recorded in the span of 20 days since release when abut 40% of all released marked spruce bark beetles were caught. The respective percentages of individuals entrapped out of the total number of marked spruce bark beetles to distances of 400, 800 and 1200 m: 39.6; 53.2 and 7.2%. In the summer season 49.5% individuals of spruce bark beetle were caught out of the total number of released marked beetles. The highest entrapment of beetles was recorded in the span of 40 days after release, but also in the subsequent decades the entrapment was active. To distances of 400, 800, and 1200 m, 14.2%, 62.5% and 23.3%, respectively, of individuals were caught out of the total number of marked spruce bark beetles. These results have demonstrated that in the summer season the spruce bark beetles are flying more days and to greater distances than they do in the spring season (Zumr, 1990).

The behaviour of spruce bark beetle *I. typographus* L. coleoptera scolytidae during flight time in mixed forest stands. In the ecosystems of mixed stands of beech and spruce in Southern Bohemia (Czechoslovakia) trials were made to investigate the behaviour and orientation of spruce bark beetle *I. typographus* L. during flight time. Marked imagoes of spruce bark beetle and pheromone traps located in forest stands at distances of 200, 400 and 1000 m were investigated. Out of the total number of marked spruce bark beetles only 65.6% individuals were caught in pheromone traps. The highest numbers of individuals was caught in pheromone traps at a distance of 1000 m from the place of release 67.8%; at distances of 400 m and 200 m the percent of entrapped beetles made 18.8% and 13.4% of the total number of caught marked spruce bark beetles, respectively. The number of entrapped beetles in dependence on exposure: western exposure 45.5%, eastern exposure 37.5%, southern exposure 12.9% and northern exposure 4.1% of the total number caught marked spruce bark beetles. During flight time of marked beetles, the highest catch of spruce bark beetles was recorded on to the first day after release them fly, on the following days it was decreasing. Four days after release, no marked spruce bark beetles were caught in pheromone traps (Zumr, 1991).

3. MATERIALS AND METHODS

3.1. Localities

The field experiments were carried out at two localities, Ismailia (30°35′N 32°16′E) and Sharkia (30°36'27"N, 31°44'47"E) localities in Egypt Fig. (1). Ismailia locality is placed at Suez Canal and Mediterranean Sea, 20 km southerly from the Mediterranean seashore (Port Fuad). Sharkia locality is placed in the delta of river Nile the distance 84 km south-westerly from the Mediterranean seashore (Port Fuad). Both localities are placed in wind blowing direction. In the area of Gulf of Suez, the average wind speed is ranging between 7 - 10 m/s on the ability to a height of 50 m from the surface of the earth, and the wind speed is high especially in the direction of west to east of the river Nile Valley, between latitudes 27°N, 29°south (Abd Allah, 2013).

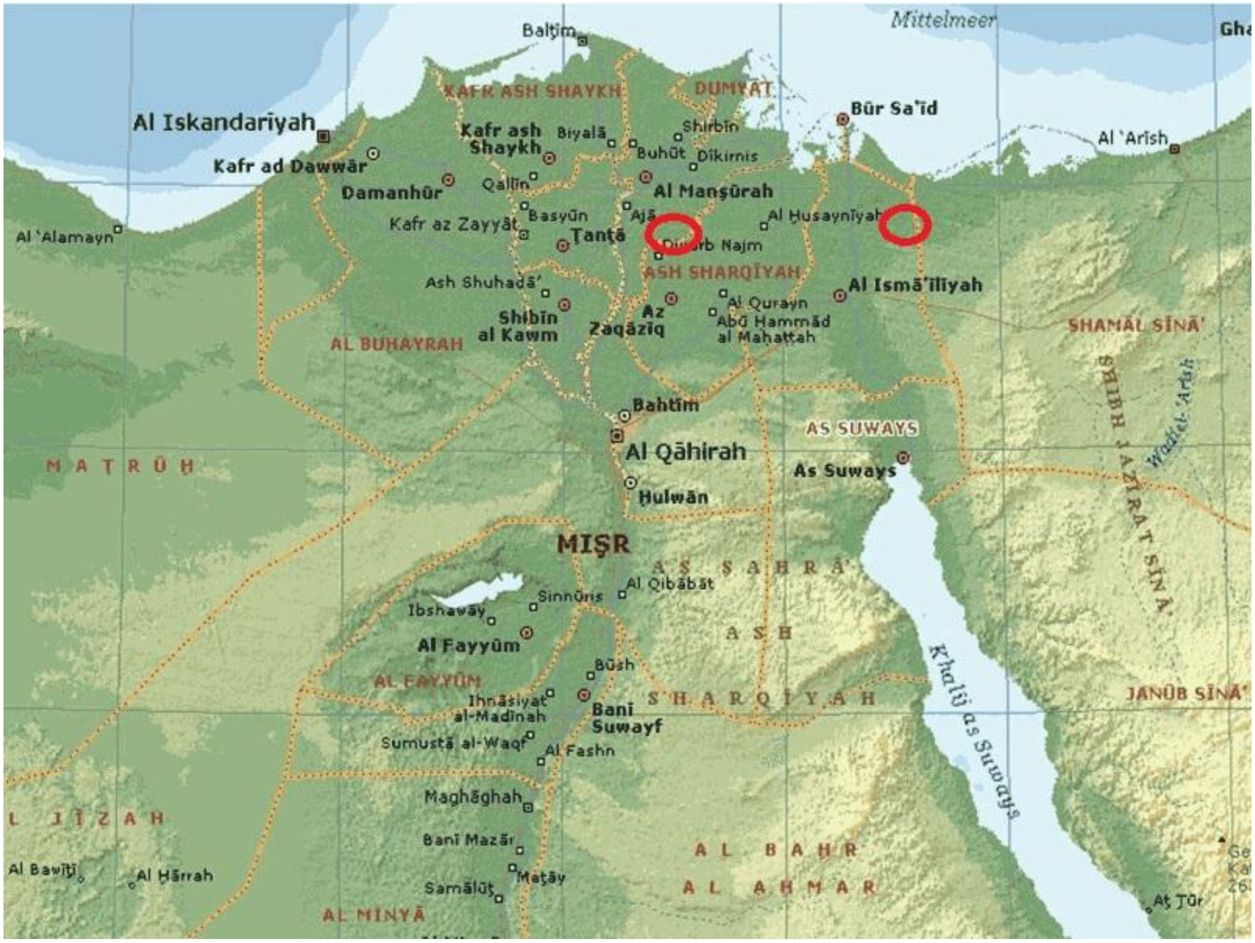

Fig. 1. Map of Delta Egypt cleared 10 sites of pheromone traps distributed in both two localities (Sharkia and Ismailia) during period (May till September 2012)

Traps were placed in the orchards containing wood trees and fruit trees such as *Casuarina glauca* (Linné), *C. Cunninghamiana* (Miquel), *Eucalyptus resinifera* (F.Muell.), *E. Citriodora* (Hook.), *E. Camaldulensis* (Dehn.), *Ficus nitida* (Blume), *F. Benghalensis* (Linné), *Salix babylonica* (Linné), *Tamarix articulate* (Vahl), *Cupressus sempervirens* (Linné), *Azadirachta indica* (A.Juss), *Poinciana regia* (Bojer), *Olea europaea* (Linné), *Phoenix dactylifera* (Linné), *Citrus* sp. (Krabbe), *Mangifera foetida* (Lour.)and *Morus alba* (Linné).

3.2. Trapping Method

Theysohn pheromone slot traps (Ridex s.r.o., Vrbno pod Pradědem, Czech Republic) were hanged on fruit trees 2 m above the ground. A 49- × 49-cm collection sheet was installed 1.5 m above the ground. Five traps were distributed in both localities (in 20 to 50 m spacing). Orientation was perpendicular to wind direction (North to West) Fig (2).

Fig. 2. Theysohn pheromone slot traps (Ridex s.r.o., Vrbno pod Pradědem, Czech Republic), hanged on trees in experimental area.

A cut-off evaporator pheromone lure (IT Ecolure®; Fytofarm Group s.r.o., Mělník, CZ) with the active ingredient (S)-cis-verbenol (3.0%), ethanol (85.2%), and synergic components (11.8%) was affixed to the trap. The evaporator was replaced according to the manufacturer’s label instructions. The first cut at the designated place was performed during hanging, and the second cut was made 6 weeks later; after two additional weeks (total of 8 weeks), the evaporator was replaced.

Beetles were sampled monthly from 1 May to 30 September 2012. The caught insects were identified by mean of stereomicroscope to their categories (orders, oamilies, genera and species which normally exist as crop pests in the same places). Taxonony was used according to (http://130.235.11.35/entomology.php). Bark beetles were determined by Dr. M. Knížek, Anobiidae by prof. P. Zahradník and Anthribidae by M. Trýzna (all Czech Republic).

4. RESULTS AND DISCUSSION

No specimen of *I. typographus* was collected during this study although is possibility to introduce *I. typographus* with package material into some Egyptian port. Traps were situated on the south from seashore in the distance 20 and 80 km. The spruce bark beetle has demonstrated strong dispersal capability (Botterweg, 1982). In the case of successful introduction into ports, beetles would find host, follow wind blow direction and could be catch in studied areas Sharkia and Ismailia districts in East Delta, Egypt.

In an extreme case *I. typographus* adults were captured on a baited log 43 km from the nearest spruce forest (Nilssen, 1984). Beetles were found in the stomach of trout in lakes 35 km from the nearest spruce forest (Nilssen, 1978). Laboratory experiments have also shown that adult *Ips* spp. can fly continuously for several hours. *I. typographus* is capable of dispersing more than several kilometers per year through its own movement or by abiotic factors such as wind, water or vectors (Eglitis, 2006). It means that collection of beetles could be possible.

I. typographus' range is limited by the thermal environment rather than host availability in many regions of Eurasia. Climate change could thus facilitate the colonization of higher altitude and latitude *P. abies* forests by means of natural dispersal. If introduced into areas with spruce forests, this insect may pose serious threats to spruce forest ecosystems, landscape trees and ornamental tree industries (Seidl *et al.*, 2008). Due to the lack of host tree and true forests in Egypt (Agricultural production statistics, 2008), it could not be not a serious problem.

All insects trapped in the study were considered as non-target species in pheromone traps of type Theysohn baited with *I. typographus* aggregation pheromone. Using Theysohn trap in natural range of *I. typographus*, some non-target species are collected. This portion is very low in comparison with catch number of bark beetle (Abgrall and Schvester, 1987; Kretschmer, 1990).

Generally, the data showed in Tables (2; 3; 4; 5) cleared that the insects caught in pheromone traps were belonging to seven orders, the results of these orders was discussed as the following:

4.1. Order: Coleoptera:

Ten families of Coleopterous insect were surveyed. These families included 20 coleopterous species. These families can be divided to some groups as the following:

1. Bark beetles group:

   Four families were recorded:

   (a) **Family Scolytidae**: includes 3 species *Xyleborus saxesenii* (Ratzburg, 1837); *Coccotrypes dactyliperda* (Fabricius, 1801); *Scolytus amygdali* (Guerin, 1847), were occured in both regions and more in Shakia region than Ismailia, where the total number of individuals atracted reached to 17 individuals , only three individuals found in Ismailia region.

   Scolytid beetles attractant in pheromone traps were more abundant in Sharkia than Ismailia due to that the orchard in Sharkia are abundant with fruit trees (Date palm; Mangoes; Citrus) and Wood trees (as mentioned above in materials).

   One species *X. saxesenii*, was recorded for the first time recoding in Egypt comparing with the journal of Society of Entomology of Egypt (Alfieri, 1976).

   (b) **Family Anobiidae**: include five species *Gastrallus corsicus* (Schislsky, 1898); *Scobicia chevrieri* (Villa & Villa, 1835); *Lasioderma sericorne* (Fabricius, 1792); *Metholcus phoenicis* (Fairmaire, 1859); *Stagetus profunda* (LeConte, 1865).The more anobiidae was found in Sharkia (3 individuals) than in Ismailia (1 individual). Three species *G. corsicus*; *M. phoenicis*; *S. Profunda*, were recorded as the first time recoding in Egypt comparing with the journal of Society of Entomology of Egypt (Alfieri, 1976).

   (c) **Family Bostrichidae**: one species was caught in traps *Dinoderus minutes* (Fabricius, 1775). More attracted Bostrichidae was more found in Ismailia (2 individuals) than in Sharkia (1 individual).

   (d) **Family Curculiondae**: four species were caught in traps i.e. *Phytonomus brunipenis* (Boh. in Schoenh., 1842); *Staphylinus oryzae* (Schoenherr, 1838); *Rhyncolus culinaris* (Dejean, 1821); *Allandrus interruptus* (Reitter, 1898). More attracted Curculionidae was found in Sharkia (13 individuals) than in Ismailia (1 individual). One species *A. interruptus* was recorded for the first time recoding in Egypt comparing with the journal of Society of Entomology of Egypt (Alfieri, 1976). Only one species was considered as bark beetle where the others were infested clover as predators.

(e) **Families i.e. Staphylinidae; Tenebrionidae; Coccinellidae; Carabaeidae; Bruchidae:** had little species in each with little numbers and differed between as crop pests or predators as shown in Tab.(2).

Generally, Coleoptera families and species caught in pheromone traps as non-target insects were more abundant than other orders. The most of Coleopterous species are known to live in Egypt and have been collected for example by Alfeiri (1976), except of five species that are recorded first time in Egypt. Alfieri (1976) started collection in 1907.

Table 2. Species of coleopterous sampled in pheromone traps baited by aggregation pheromone with ethanol and cis-verbenol during period (May-September 2012) in Sharkia and Ismalia regions in Egypt (new records are in bold)

Order: Coleoptera	Sharkia region	Ismalia region	Author/Year
Family: Scolytidae			
Xyleborus saxesenii	1		Ratzburg, 1837.
Coccotrypes dactyliperda	4		Fabricius, 1801.
Scolytus amygdali	9	3	Guerin, 1847.
Family: Anobiidae			
Gastrallus corsicus	2		Schislsky, 1898.
Scobicia chevrieri	1		Villa & Villa, 1835.
Lasioderma sericorne		1	Fabricius, 1792.
Metholcus phoenicis		1	Fairmaire, 1859.
Stagetus profunda		1	LeConte, 1865.
Family: Bostrichidae			
Dinoderus minutes	1		Fabricius, 1775.
Family: Curculionidae			
Phytonomus brunipenis	1		Boh. in Schoenh. , 1842.
Staphylinus oryzae	1		Schoenherr, 1838.
Rhyncolus culinaris	13		Dejean, 1821.
Allandrus interruptus		1	Reitter, 1898.
Family: Staphylinidae			
Paederus alfieri	2		Koch 1934.
Family: Tenebrionidae			
Tribolium castanum	8	4	Herbst, 1797.
Family: Coccinellidae			
Coccinella. undicimpunctata	3	2	Linnaeus, 1758.
Scymnus punctillum	1	1	Weise, 1891.
Family: Carabaeidae			

Carabus hemprichi	1	1	Dejean, 1826.
Family: Chrysomelidae			
Cassida vittata	1	1	Villers, 1789.
Family: Bruchidae			
Bruchus alfierii		1	Pic, 1923.

Comments to bark beetles and new records.

Xyleborus saxesenii was first described from southern Germany (Cognato *et al.*, 2005). It is commonly found in the forests of Europe, Africa, and Asia. It is also now present as an introduced species in North America (United States and Canada), Australia, and New Zealand (Cognato *et al*., 2005; Walker, 2009). In New Zealand there are six records in hardwood and softwood casewood, dunnage and sawn timber with origin from Australia, Ecuador, South Africa, USA (Brockerhoff *et al.*, 2003). It has a wide host range that includes ornamental trees, stone fruits and timber. Almost all conifers and hardwoods are susceptible (Walker, 2009). Economic damage to stone fruits, including apricots and plums has been particularly devastating (Steiner, 2003). First record in Egypt.

X. saxesenii is known to be attracted to lures containing ethanol (Roling and Kearby, 1975; Montgomery and Wargo, 1983; Klimetzek *et al*., 1986; Petrice *et al*., 2005; Miller and Rabaglia, 2009**)**. Therefore it is possible to react on IT Ecolure containing 85.2% ethanol.

Coccotrypes dactylifera is widely distributed in the sub-tropics and tropics. It is widespread in most of the date palm growing areas of the world: North America, North Africa, the Middle East and India (Carpenter and Elmer, 1978; Lepesme, 1947). This species is considered to be established in New Zealand (Anonymous, 2002). *C. dactylifera* is known as a primary pest of green unripe date fruits. It feed in seeds of small-seeded palms such as those of the canary palm *Phoenix canariensis* (Linné), *Kentia* sp., and *Howea* sp. (Anonymous, 2002). Considerable damage has been reported from North Africa, India and Israel (Blumberg and Kehat, 1982; Kehat, 1966). It is probably a common species in studied area. Pheromones are unknown but we suggest that collecting of *C. dactylifera* is incidental in used traps.

Scolytus amygdali was reported in all countries around the Mediterranean, the Caucasus and Central Asia (Balachowsky, 1949; Bolu and Legalov, 2008) and Tunisia (Cherif and Trigui, 1990). *S. amygdali* is considered as a predominant species of bark beetle attacking fruit trees

(Russo, 1931; Balachowsky, 1949; Cherif and Trigui, 1990; Youssef *et al*., 2006; Bolu and Legalov, 2008). The insect lives exclusively on almond and apricot (Cherif and Trigui, 1990). It belongs among the wood pests that attack the live trees suffering from poor growing conditions (prolonged drought, etc.). The older trees of these species are also susceptible to beetle's attack and may die because of this attack under hot dry weather conditions (Mahhou and Dennis, 1992; Mendel *et al*., 1997). Aggregation pheromones have been indentified but ethanol and propanol did not affect total trap catches (BenYehuda *et al*., 2008; Lotfalian *et al*., 2008). Probably common pest in studied area collected incidentally.

Gastrallus corsicus is xylophagous widely distributed in the Mediterranean area. It is a polyphagous species, common on the Aeolian Islands, where it develops in several host plants i.e. *Bassia saxicola* (Guss); *Euphorbia dendroides* (Linné); *Olea europaea* (Linné) (Español, 1992). First record in Egypt.

Metholcus phoenicis is a mediterranean species spread in southern part of Europe from Spain to Bulgary and former Soviet Union (country Orenburg). Is is also known from Israel and northern Africa. It is quit common in south-eastern and eastern coast of Spain and Baleary Islands (Español, 1992). It was observed to feed on decay wood of *Juniperus* spp. (Mulsant a Rey, 1864) but the same authors reported that its larvae live in date twigs. Alfieri (1976) did not collect this species in Egypt but occurrence in Egypt is mentioned by (Löbl and Smetana, 2007).

Allandrus interruptus (Reitter, 1887) is known from Azerbaijan, Armenia, Iran, Israel, Jordan and Turkmenistan (Löbl and Smetana, 2011). Bionomics is unknown (Frieser, 1981). First record in Egypt.

4.2. Order: Lepidoptera:

Four families of Lepidopterous insect were surveyed. These families include 4 species attracted as non-target insects. And can be considered as fruit and crop pests found around the traps.

Recoded families are following: Crambaeidae including *Chilo agamemnon* (Blesznski, 1862), known as "lesser corn borercorn"; Phyllonsistidae including *Phyllocnistis citrella* (Stainton, 1856), known as "citrus leaf miners"; Noctuidae with *Agrotis ipsilon* (Hufnagel, 1766) and

Spodoptera littoralis (Boisdulval, 1833), which are known as “acotton pests”; Pyraustidae icluding *Pyrausta sp.* Known as “ Eurbean corn borer”.

Sampled Lepidoptera species were the most abundant Tab. (3) because of the most species are citrus life miners (Amal Zakria, 2005).

Table 3. Species of Lepidopterus sampled in pheromone traps baited by aggregation pheromone with ethanol and cis-verbenol during period (May-September 2012) in Sharkia and Ismalia regions in Egypt.

Order: Lepidoptera	**Sharkia region**	**Ismalia region**	**Author/Year**
Family: Crambaeidae			
Chilo agamemnon	5	2	Blesznski, 1862.
Family: Phyllonsistidae			
Phyllocnistis citrella	105	6	Stainton, 1856.
Family: Noctuidae			
Agrotis ipsilon	6		Hufnagel, 1766.
Spodoptera littoralis	3		Boisdulval, 1833.
Family: Pyraustidae			
Pyrausta sp.	5		Hubner, 1796.

4.3. Order: Hymenoptera:

Two families of Hymenoperous insect were surveyed. These families included 4 species. These families can be considered as social insects found around the traps.

Recoded families are following: Vespidae *Polistes gallica* (Weyrauch, 1939), known as “social insect and predator for noctuid larvae”, (1 individual) in Ismalia region: Formicidae *Componotus maculates* var *aegypticus* (Mayr, 1870), known as “social insect found as nests in fruit trees”, (3 individuals) in Sharkia region.

4.4. Order: Diptera:

Five families of Dipterous insect were surveyed. These families included 4 species. These families can be considered as medical insects or onion pests found around the traps. Recorded families can be named as the following: Muscidae *Musca demosticus* (Linné, 1758); Anthomyiidae *Delia antique* (Meigen, 1828), known as “onion pests”; Agromyzidae *Agromyza phaseoli* (Coquillett, 1899), known as “leguminous leaf miners”; Culicidae *Culex pipiens* (Linné, 1758), known as "piercing sucking blood of human and animals"; Calliphopridae *Lucilia sericata* (Meigen, 1826), known as "dead flies".

Almost all species were captured randomly. There is no reason why they would be attracted to cis-verbenol contained in used lures.

Table 4. Species of Dipterous sampled in pheromone traps baited by aggregation pheromone with ethanol and cis-verbenol during period (May-September 2012) in Sharkia and Ismalia regions in Egypt.

Order: Diptera	**Sharkia region**	**Ismalia region**	**Author/Year**
Family: Muscidae			
Musca demosticus	19	7	Linné, 1758.
Family: Anthomyiidae			
Delia antique	3	1	Meigen, 1828.
Family: Agromyzidae			
Agromyza phaseoli	1	1	Coquillett, 1899.
Family: Culicidae			
Culex pipiens	1		Linné, 1758.
Family: Calliphpridae			
Lucilia sericata	2		Meigen, 1826.

4.5. Order: Homoptera:

One family of Homopterous insect were surveyed. This family included 1 species. This family can be considered as piecing and sucking insects pests found on fruit and vegetables around the traps. The family recoded can be named as the following: Cicadellidae *Empoasca decipiens* (Paoli, 1930), it was found in Sharkia (2 individuals) but (1 individual) in Ismailia.

4.6. Order: Hemiptera:

Four families of Hemipterous insect were surveyed. These families included 4 species. These families can be considered as fruit and crop pests found around the traps or predators of insect pests (Hosny *et al.*, 1976).

Recorded families can be named as the following: Anthocoridae *Orius nigra* (Wolf, 1811), Known as "predator for aphids and mealy bugs"; Cydnidae *Cydnus aterrimus* (Forster, 1771), known as “predacous insect”; Pentatomidae *Nezara viridula* (Linné, 1758), known as “piercing sucking insect for many field or horticulture plants”; Blestomatidae *Horvathinia pelocoroides* (Montandon, 1911), known as “minorwater bugs and predator of aquatic insects”.

Table 5. Species of Hemipterous sampled in pheromone traps baited by aggregation pheromone with ethanol and cis-verbenol during period (May-September 2012) in Sharkia and Ismalia regions in Egypt.

Order: Hemiptera	**Sharkia region**	**Ismalia region**	**Author/Year**
Family: Anthocoridae			
Orius nigra	1		Wolf,1811
Family: Cydnidae			
Cydnus aterrimus		1	Forster, 1771
Family: Pentatomidae			
Nezara viridula		1	Linné,1758
Family: Blestomatidae			
Horvathinia pelocoroides		1	Montandon, 1911

4.7. Order: Dictyoptera:

One family of Dictyopterous insect was surveyed. This family included 1 species. This family can be considered as saprophyte cockroach around the traps. Recoded family was Blattidae *Blattella germanica* (Linné, 1758), (3 individuals) in Sharkia region.

Generaly order Lepidoptera presented as 53.44% relative to the total captures followed in descending order by coleopterous insects (26.72%); Diptera (14.17%), while the rest insects of other orders with little numbers approximately (1-2%), showed in Fig. (3).

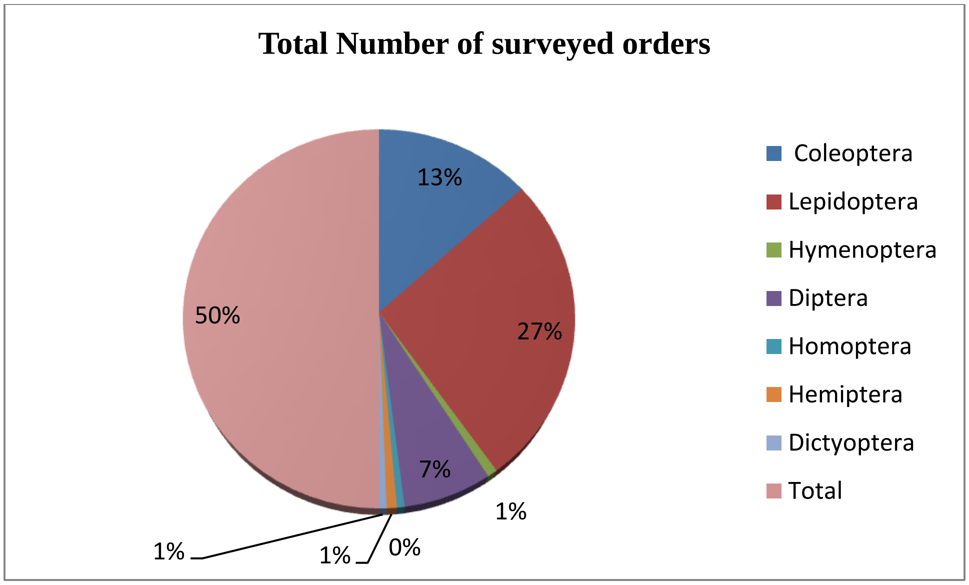

Fig. 3. Percentage of surveyed orders caught in pheromone traps baited by aggregation pheromone with ethanol and cis-verbenol during period (May-September 2012) in Sharkia and Ismalia regions in Egypt.

5. CONCLUSIONS

The surveyed insects which have been caught in Theysoh traps baited by aggregation pheromone with ethanol and cis-verbenol sited in East Delta of Arab Republic of Egypt appeared that:

1. No specimen of *I. typographus* was collected in investigation areas in wood or fruit trees during this study, but there is possibility to introduce *I. typographus* with package material into some Egyptian port.
2. All insects trapped were considered as non-target species belonging to seven orders (Coleoptera; Lepidoptera; Diptera; Homoptera; Hemiptera; Hymenoptera & Dictyoptera).
3. The most important orders which have been collected were Coleoptera and Lepidoptera, which containing the most attracted insects.
4. Bark beetles recorded families were:
    - Scolytidae: includes three species i.e. *Xyleborus saxesenii*; *Coccotrypes dactyliperda*; *Scolytus amygdali*.
    - Anobiidae: includes five species i.e *Gastrallus corsicus; Scobicia chevrieri*; *Lasioderma sericorne*; *Metholcus phoenicis*; *Stagetus profunda.*
    - Bostrichidae: include one species caught in traps i.e. *Dinoderus minutes*.
    - Curculionidae: *Allandrus interruptus.*
5. Five bark beetle species were recorded for the first time in Egypt and classified in Minstry of Agriculture in Czech Republic and haven’t mentioned in collection of Coleopterous of Egypt.
6. The most of the insects caught in pheromone traps were considered as plant pests or social or saprophytes insects in small numbers and live around the area of capturing.
7. Theysohn trap appeared that it was more usefull for collecting the target or non-target other bark beetles.
8. There are important research devices that should be use this techniques (Theysohn traps) to discover bark beetles in ports which accompanied woods imported from Europe or other parts.
9. Some ideas must be taking in consideration that establishment a project between research centers in both Czech Republic and Republic of Egypt.

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