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# Hand-held electric Aspirator "ElePooter": a cheap and efficient device for collecting insects

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**ABSTRACT.** Several methods are using to collect insects from the environments, they are living in. The sweeping net is one of the commonly used equipment for collecting however the process of picking up the collected insects from net bag is laborious and time consuming job. In the present work we introduced a hand-held battery powered electric aspirator, which made based on a centrifugal fan which adapted into an especial storage bottle (replaceable). Field trials confirmed the efficiency of the new device in collecting insects from different orders, of which Diptera and Hymenoptera were dominant. Additional customization was made on the type of collecting bottle to enhance the applicability of the new device for different purposes. Finally, studies showed that the hand-held electric aspirator can be used successfully for faunistic and ecological studies.

**Key words:** Insects, spiders, sampling, pooter, new device, portable, transferring.

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## Introduction

Insects are one of the most important and overcrowded creatures in the world. They play a major role in the evolution and maintenance of biotic communities (Sanderson & Jackson, 2002). They are the most diverse group of animals on the planet, including more than a million of described species and representing more than half of all known living organisms (Stork et al., 2015). On the other hand, increasing the knowledge about these organisms is critically important in the case of insect pests. Entomologists collect insects for taxonomical, ecological and physiological studies (Borror et al., 1989). Different methods and equipments are used for collecting the insects. One of the most common is the sweeping net, used for collecting insects in the field. Sweep netting through vegetations is one of the well known and most common methods (Martin, 1977). Depending on the environment, various numbers of insect (and spider) specimens lumping inside the net bag, and it is necessary to collect them properly. Various methods are suggested for separation of specimens from the net bags (Gibb & Oseto, 2006). The aspirators,

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known also as 'pooter' are convenient and effective device for collecting insects captured by the sweep net. Different kinds of the pooters are made for various purposes and can be used according to their own advantages (Martin, 1977; Upton & Mantle, 2010). The most common type of aspirator is a simple suction device for picking up a few number of insect or selecting a few specimens out of a large number of the materials inside the sweep net. The standard aspirator consists of a collecting bottle fitted with a rubber bung, through which two metal tubes are passed. One tube, with muslin or organdie over the end in the bung and another one is bent to approximately 140$^{o}$ from one end (Schauff, 2001). The tubular aspirator is another simple aspirator that consisting of a collecting bottle, opens at both sides. The suction bottle fits through a cork at one side and the open bottle similarly at the other (Upton & Mantle, 2010). A blow-type aspirator is similar to vial or tubular aspirator that the t-shape attachment is substituted with glass bottle (Gibb & Oseto, 2006). The "Singer" aspirator is also a modified version for collecting mites and small insects, particularly from plants and makes separate collections in rapid succession without any risk of mixing the specimens. It consists of three bottles (intake, suction and body bottles) and collecting vials (Singer, 1964; Martin, 1977). An improvement to the mouth-operated aspirator was reported by Farr (1989), who developed a pump aspirator for collecting small insect around hazardous material. The valve is substituted with a suction bottle in common aspirator and suction with mouth is eliminated.

The electric or motorized aspirators have the suction features that applied for large scale sampling and are different in power and size due to their application. These include the hand-held converted dust booster insect vacuum, D-vac (which employs a backpack motor fan) (Dietrick et al., 1959), Insectavac (Ellington et al., 1984), Aspirator-Gun (Toth, 2000). Other devices are also designed for direct collecting of the honey bees (Gary & Marston, 1976) and the mini aspirator for collecting and transferring small arthropods (Dogramaci et al., 2011). All the above mentioned aspirators have their own merits and faults. In order to overcome some of the limitations, we developed a hand-held electric aspirator named as "ElePooter".

## Material and methods

### *Designing and Assembling*

The ElePooter (Fig. 1A) has four main components: The centrifugal fan (Fig. 1B), manifold (Fig. 1C), chargeable battery (Fig. 1D) and a box (Fig. 1E). A plastic collecting bottle of 11 cm height × 4.5 cm in diameter and 120 cc volume, used as the storage chamber. A piece of 40-mesh wired screen was fastened over the end of this bottle to prevent dust and scratches from getting into the manifold and fan. The opposite end of bottle was open for collecting of insects. This bottle was directly inserted into the manifold. The manifold was the PVC tube, which mounted between the storage bottle and the centrifugal fan. The manifold was attached to the centrifugal fan and both are placed inside the box (Fig. 1A). The ElePooter was powered by an electrical fan (MINEBEA CO., LTD., 12V, 2.1A) (Fig. 1B). High pressure developing over this piece was found to pull air from storage bottle. The energy of fan was provided by a chargeable battery (l2V, 4.5Ah). Other parts include the wire, switching key, handle and electricity adaptor.

### *Field experiments (Collecting insects)*

In the course of a small scale experiment, specimens were collected by standard sweeping net on alfalfa field in the Giok region (32°47'N; 59°07'E; 1917m) of Southern Khorasan province (Eastern Iran).

Sweeping were performed strongly from right to left in a full 180°, one stroke per step and over top of the alfalfa canopy for once. The spending time of sweeping net in the field was 20 minutes. The weather was sunny and without wind at the time of sampling. After sweeping, very large insects (large locusts, butterflies and wasps) and large plant remnants were removed from the net and the insects were then picked up using the ElePooter (Fig. 2A). All specimens were collected directly via entrance of the transparent storage bottle (tip of the ElePooter). Later, specimens were transferred to the cage or alcohol container (Figs 2A–C).

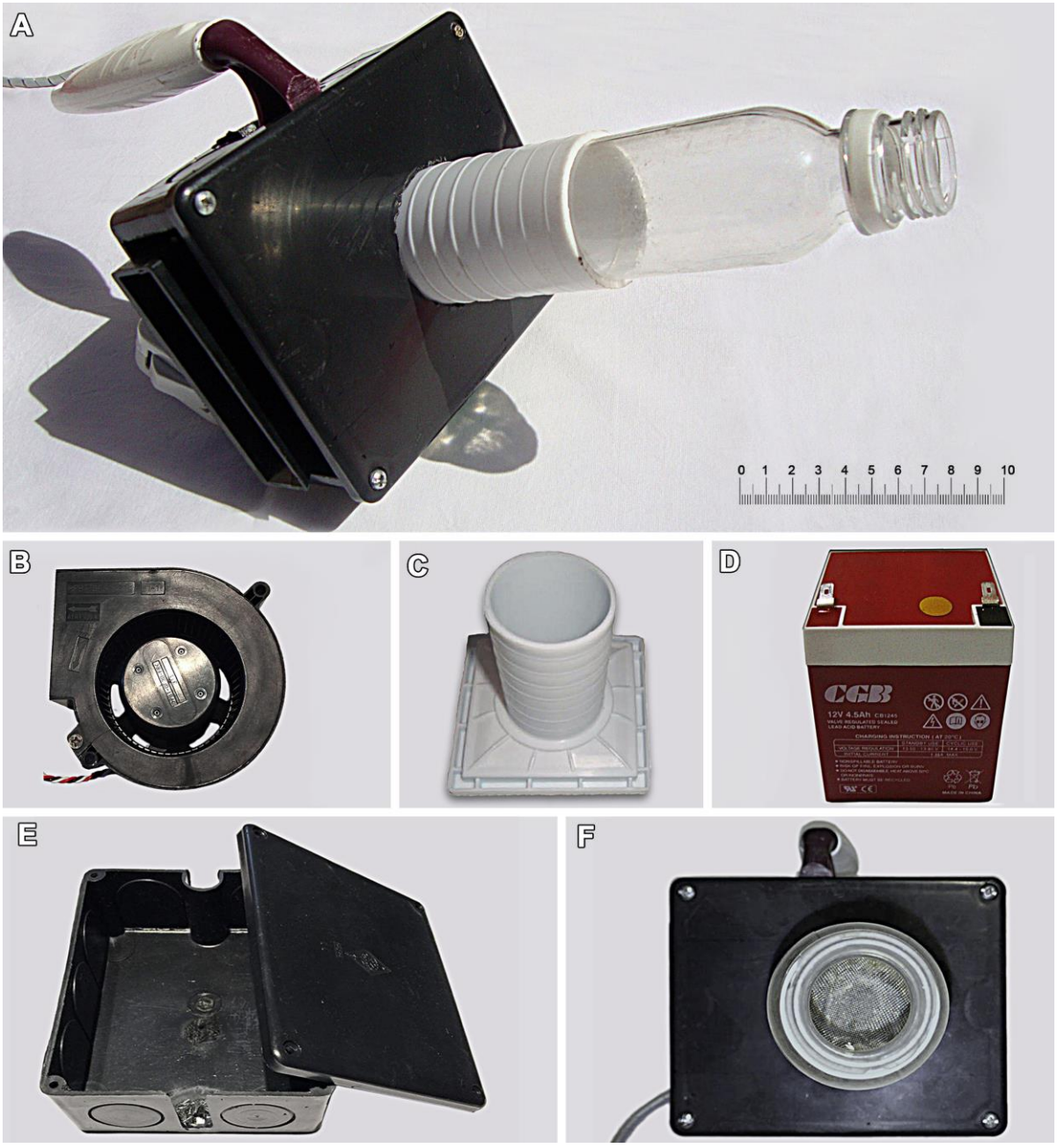


**Figure 1.** The ElePooter apparatus and its components: **A.** The complete system in lateral view; **B.** Centrifugal fan; **C.** Manifold; **D.** Chargeable battery; **E.** Main box; **F.** Frontal view of the device.

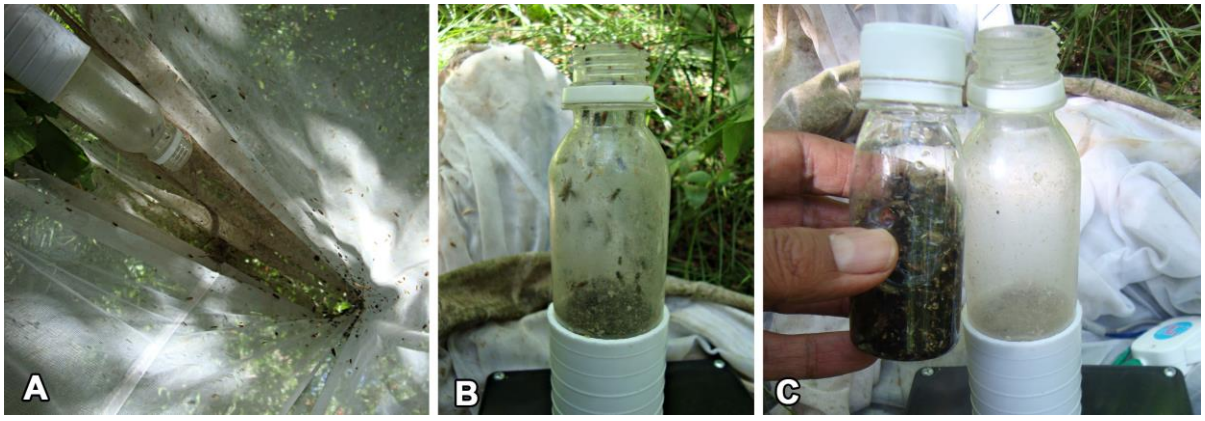


**Figure 2.** Specimens collected using the ElePooter: **A.** Specimens in the sweep net; **B.** Live specimens in the collecting bottle; **C.** Specimens in the vial with alcohol.

**Customizations**

In order to increase the applicability of the ElePooter for different users and for various purposes, some customizations were made on the device. An auxiliary plastic ring was mounted on the tip of the manifold which allow the user to shift the bottle size from 125 to 100 cc (Diameter ranged from 3–4.5 cm) (Fig. 3).

The second modification was based on the positive phototropism of the insects inside the collecting bottles. It was replaced with a dark collecting bottle by the same size and quality (Fig. 4A). The same procedure was made for collection of specimens from the net bag, while they stored evenly inside the dark bottles. Thereafter, the dark bottles separated from the device and each of them was attached to a clean transparent bottle using a pair of white caps, stalked on their opposite sides (Fig. 4C). The connected bottles were laid on the ground horizontally (Fig. 4C) and the insects allowed for a period of 10–15 minutes to arbitrarily moving into the transparent bottles. The transparent bottles were then separated and the collected insects were submerged with ethyl alcohol 75%. The plant material, as well as insects remained inside the dark bottle were collected and inspected separately.

**Results**

A total of seven insect orders in different size (1–20 mm) and spiders were collected by ElePooter (Figs 5A–D, Table 1). Maximum and minimum percentages of collected insects according to taxonomic groups belong to Diptera and Thysanoptera/ Orthoptera with 34% and 0.9%, respectively (Table 1). Frequencies of collected insects according to their size were 55% for 1–5 mm, 23.6% for 5–10 mm and 21.3% for 10–20 mm. The insects and spiders were collected safely from the net bag into the preserving bottles. Few damaged specimens (1–2%) were detected, which most probably sourced from the impacts on the net with plant material at the time of sweeping.

In use of the dark storage bottle (insects with positive phototropism), revealed that the majority of collected insects moved to the transparent bottle (Fig. 5E), while some insects consisting two groups, one with negative phototropism (nymph of Hemiptera and spiders) and another that was damaged by the net, were remained inside the dark bottles.

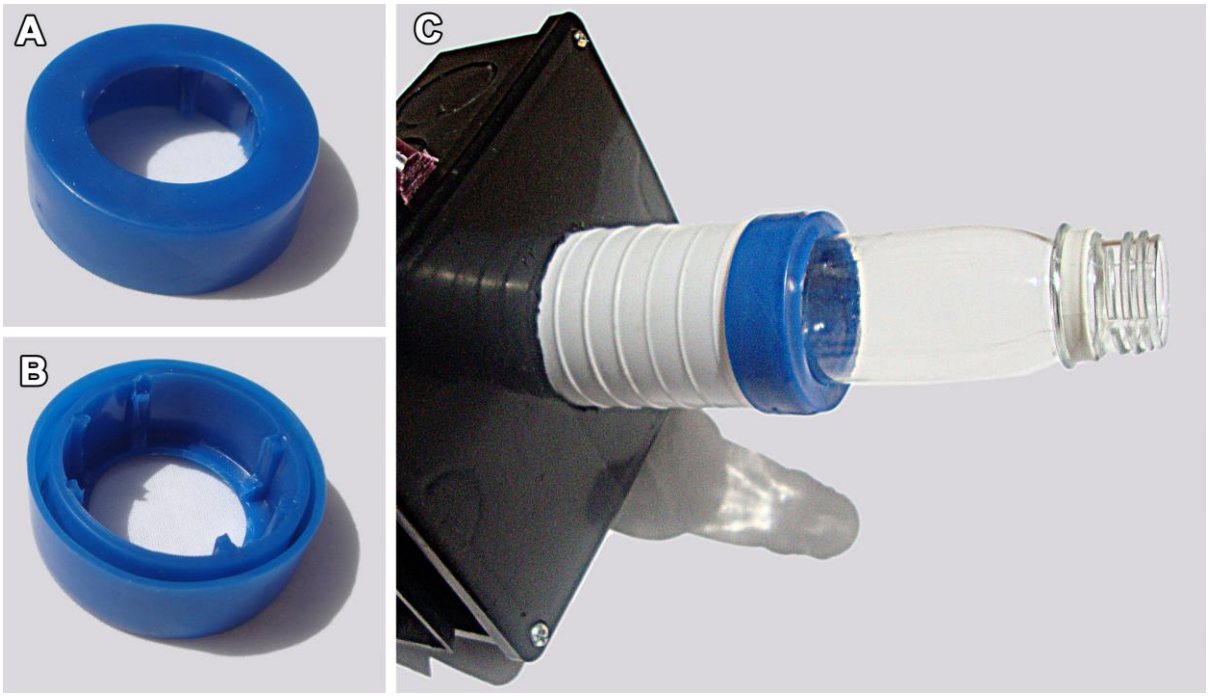


**Figure 3.** Assembly of the coupling and small storage bottle of the ElePooter: **A.** Coupling in frontal view; **B.** Coupling in dorsal view; **C.** Mounted smaller bottle.

## Performance

The new device (ElePooter) indicated a high rate of performance and efficiency on the basis of the suction power and battery life time. The volume of air moving through this system, also known as "Cubic Feet per Minute", is 28–58 CFM and the speed fan was 3700 RPM. The charging period of battery was 8 hours in first use and 2 hours for next times, in average. Two hours of continuous usage with maximum performance was needed to discharge the battery, while a maximum duration of three hours last in normal application. The designing structure of the centrifugal fan simply allowed the dust and plant material to pass through the outlet valve and no residue was detected inside the device after long term application.

**Table 1.** Frequency of the specimens collected in alfalfa field, using the ElePooter.

| Orders | Superfamilies/families | Frequency |
|---|---|---|
| Hymenoptera | Apoidea, Chalcidoidea, Chrysidoidea, Cynipoidea, Formicidae, Ichneumonoidea, Platygastroidea, Proctotrupoidea, Vespoidea (including Pompilidae) | 31.8% |
| Diptera | Chamaemyiidae, Agromyzidae, Chrolropidae, Conopidae, Asilidae, Tephritidae, Tachinidae, Muscidae, Phoridae, Chironomidae, Pipunculidae, Culicidae, Syrphidae, Calliphoridae, Dolichopodidae | 34% |
| Hemiptera | Miridae, Anthocoridae, Coreidae, Alydiddae, Nabidae, Geocoridae, Pentatomidae Cicadellidae, Delphacidae | 22.2% |
| Orthoptera | Acrididae (nymphs) | 0.9% |
| Thysanoptera | Aeolothripidae | 0.9% |
| Aranea | Gnaphosidae, Lycosidae, Salticidae, Philodromidae, Thomisidae | 1.8% |
| Coleoptera | Coccinellidae, Carbidae, Chrysomellidae, Curculionidae | 3.6% |
| Neuroptera | Chrysopidae, Hemerobiidae | 1.3% |


**Figure 4.** Specimens collected using the ElePooter with dark storage bottle: **A.** The complete system; **B.** Dark storage bottle; **C.** Coupled dark and transparent collecting bottles.

## Discussion

An operator using the ElePooter can collect insects of different orders, as well as the spiders in various sizes (1–20 mm) that can be very useful for the taxonomists in the field. Similar devices were designed that collect only smaller arthropods (Thysanoptera) (Dogramaci et al., 2011), mosquitoes (Aldridge et al., 2012), spiders and insects (Toth, 2000) and Coleoptera (Teshler et al., 2004). Many research projects have recently been initiated on Diptera and Hymenoptera (Stuke et al., 2014; Izadizadeh

et al., 2015; Ghafouri Moghaddam et al., 2016; Ranjbar et al., 2016; Peris-Felipo et al., 2016; Yari et al., 2016; Derafshan et al., 2016; Kazerani et al., 2017; Ghotbi Ravandi et al., 2017; Motamedinia et al., 2017a, b), which can use this device for collecting the insects both directly and from the net. The same advantages can be expected for successful sampling of many other insect groups, i.e. leafhoppers and planthoppers (Mozaffarian & Wilson, 2016), plant bugs (Malvandi et al., 2015) and thrips (Mirab-balou, 2016).

The ElePooter is a nonspecific device which can collects a wide range of taxa. Using a dark bottle make it possible to separate more active and diurnal insects, easily. Very tiny insects, i.e. Trichogramatidae and Mymaridae (Hymenoptera) which are hardly collected by other methods (Dogramaci et al., 2011), can easily pass through the gauze and simply ignored, as a general deficiency of ElePooter ver. 1. It can be solved in the future versions using fine gauze with smaller mesh.

In the field trial some collected insects tend to stay inside the dark bottle to transparent bottle. Among them some specimens like spiders (negative phototropism) and nymph of plant bugs, lacking the ocelli (Nakamura & Yamashita, 1997; Borror et al., 1989), weren't moved in to transparent bottle. The others were damaged at the time of sampling. The ElePooter can also to be highly efficient for collecting small and medium sized insects attracted to the light sheets (Upton & Mantle, 2010), and only the transparent bottle should be used in this case. However, the latter subject was not examined in this study.

The conventional aspirators are limited by the inhaling small particles, fungus spores, noxious fumes and collecting small part of capturing insects (Douglas, 1984; Gibb & Oseto, 2006; Upton & Mantle, 2010). The ElePooter simply eliminates these problems and directly save the time required to collect insects from the sweep net and indirectly increase the sampling time in the field. The powerful battery is another advantage of this device that provides the energy of the fan during operation for a long time. A complete ElePooter weights approximately 1.8 kg, including the battery (1kg) that can be carried by a backpack. Therefore the operator can easily use the device and collecting insects without any problem. The ElePooter has more advantages comparing other commonly aspirators that shown in Table 2.

**Table 2.** General comparison of ElePooter with other commonly used aspirators for collecting insects.

| | **Hand pooter** | **AC/DC Aspirator (BioQuip®)*** | **New Device (ElePooter)** | **Backpack Aspirator (BioQuip®)** |
|---|---|---|---|---|
| **Weight** | Very light | Light | Medium | Heavy |
| **Portability** | Very good | Fair | Good | Poor |
| **Costs** | Very Cheap (8.1$) | Expensive (88.7$) | Cheap (32.4$) | Expensive (1054.5$) |
| **Selectivity** | Very good | Fair | Fair | Poor |
| **Battery life time (hr)** | - | 2 | 3 | 3 |
| **Rate of escape** | Very high | Low | Very low | Very low |
| **Size of captured insects** | S & M | S & M | S & M | S & M & L |
| **Suction power** | Very low | Low | High | Very high |
| **Holding capacity** | Very low | Low | High | High |
| **Specimens safety** | Low | Medium | High | Medium |
| **Area of applicability** | Field & Lab. | Field & Lab. | Field & Lab. | Field |
| **Durability** | Low | Medium | High | High |
| **General efficiency** | Very low | Low | High | High |

* Data available from BioQuip Inc., https://www.bioquip.com

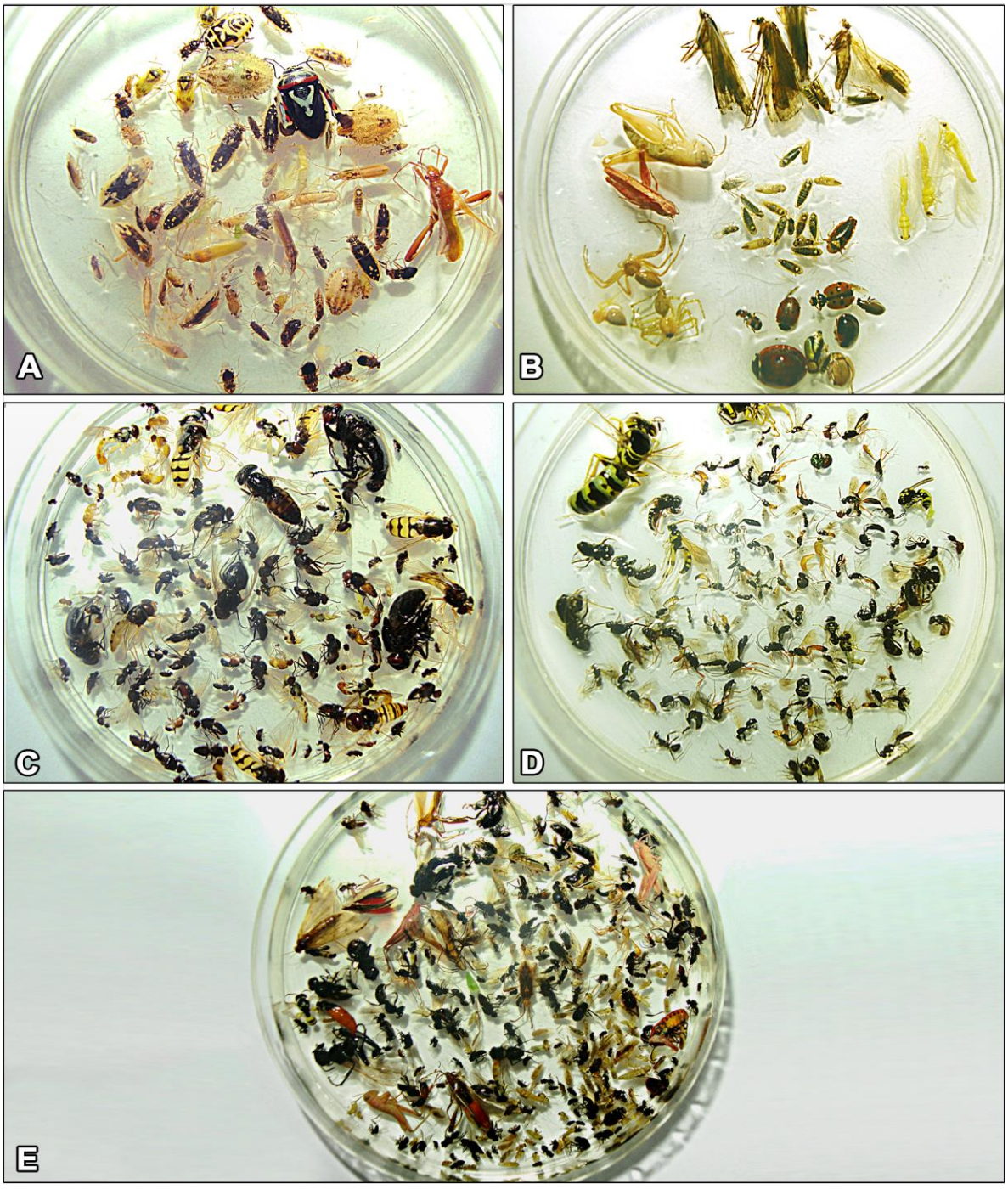


**Figure 5.** Specimens collected using the ElePooter: **A.** Hemiptera; **B.** Orthoptera, Coleoptera, Neuroptera and Aranea; **C.** Diptera; **D.** Hymenoptera; **E.** Specimens which transferred from the dark collector into the transparent bottle via positive phototropism.

In general, it is light weight, portable, durable, easy to construct and cheap, and can be used for multiple years. This device described herein can be modified in future version for collecting and transferring biological agent as well as smaller insect like thrips and acari in the field and laboratory for taxonomical and bio-ecological studies.

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**Conflict of Interests**

The authors declare that there is no conflict of interest regarding the publication of this paper.

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# آسپیراتور برقی قابل حمل، "ElePooter" : ابزاری موثر برای جمع‌آوری حشرات

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**چکیده:** روش‌های متعددی برای جمع‌آوری حشرات از زیستگاه آنها استفاده می‌شود. تورجاور، یکی از ابزارهای متداول در این زمینه به شمار می‌رود، اما فرایند جمع‌آوری و انتقال حشرات از داخل کیسه تور، کاری دشوار و زمان‌بر است. در این مقاله، یک نوع آسپیراتور برقی قابل حمل متصل به باتری معرفی می‌شود که بر مبنای اتصال یک پروانه مکنده مرتبط با ظرف جمع‌آوری ساخته شده است. بررسی‌های صحرایی نشان داد این ابزار کارایی بسیار خوبی در جمع‌آوری حشرات راسته‌های مختلف دارد که در بین آنها دوبالان و بال‌غشاییان اکثریت داشتند. به منظور افزایش کارایی ابزار در زمان استفاده با اهداف مختلف، یک سری تغییرات در محفظهٔ جمع‌آوری داده شد. در مجموع، بر اساس آزمایش‌های انجام شده، آسپیراتور برقی قابل حمل را می‌توان با موفقیت در هنگام انجام مطالعات فونستیک و اکولوژیک استفاده کرد.

**واژگان کلیدی:** حشرات، عنکبوت‌ها، نمونه‌برداری، پوتر، ابزار جدید، قابل حمل، انتقال.