

First Record of Eucalyptus Gall Wasp (EGW) (*Ophelimus maskelli*) (Ashmead) on *Eucalyptus* *camaldulensis* in Ethiopia

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Abstract Survey was conducted at major eucalyptus growing areas of Amhara, Tigray National Regional States and at Addis Ababa City in 2016/2017 and 2017 to determine the status of major insect pests with emphasis on the gall making wasps on Eucalyptus species. An invasive insect pest, Blue Gum Chalcid, observed on plant parts and growth of seedlings at field and in nurseries, on coppiced young trees and on new shoots of old *Eucalyptus camaldulensis*. The Blue Gum Chalcid (BGC) (*Leptocybe invasa*) (Fisher and La Salle) had been reported in Ethiopia since 2000 as it is mentioned in ICFR, (2011); 2002 by Giliomee, (2011). The Eucalyptus Gall Wasp (EGW) also known as Blade Gall Wasp (BGW) (*Ophelimus maskelli*) (Ashmead), is the other gall making insect pest that newly occurred and accidentally arrived to Ethiopia. At first time, it was observed since February 2017, on one-year and above aged coppiced *Eucalyptus camaldulensis* tree species at Kombolcha, South Welo, Amhara National Regional State on urban eucalyptus coppiced trees. *O. maskelli* develops in a single-cell-type gall. The galls are pimple-like, nearly round and occur only on the leaf blade; under epidemic conditions the entire leaf surfaces are usually densely covered with galls. Heavy infestation induces much galling in leaves, which results in widespread defoliation and loss of growth and vigor in susceptible eucalyptus trees (Protasov et al., 2007). Similar and typical attack and damage symptoms of this Eucalyptus Gall Wasps were observed during the survey tours that were conducted in the major Eucalyptus growing areas of three regional states of Ethiopia. Both wasps found mainly attacking and caused damage on *Eucalyptus camaldulensis*. The distribution of the *Leptocybe invasa* on its host is almost in all areas of the surveyed regions while the recently occurred gall making wasp, *Ophelimus maskelli*, at the moment, found/ localized / on the trees in few districts of Amhara region and in Addis Ababa City, but it is the disseminating invasive insect pest in alarming rate on *Eucalyptus camaldulensis*. Integrated Insect Pest Management Strategy is required for both insect pests but for the one that recently occurred, for the Eucalyptus Gall Wasp, a physical control option, that is pruning the attacked and infested plant parts/ mainly leaves/, remove infested plant parts from the fields and burning the pruned plant materials which could be used as fuel materials. For other new areas domestic quarantine should be attempted. These practices, to be suggested as an immediate control option practices. In the near future, classical biological control option that includes introducing of natural enemies from their native place to Ethiopia will be the effective and safe to the environment that could be promoted in controlling EGW.

Keywords Biological control, Blue Gum Chalcid, distribution, Eucalyptus Gall Wasp, *Eucalyptus camaldulensis*, Eulophidae, Gall making insects, Hymenoptera, Invasives, *Leptocybe invasa*, *Ophelimus maskelli*, Species, Symptoms

1. Introduction

Eucalyptus species are one of the dominant forest trees in Ethiopia. The Eucalyptus is exotic which was introduced to Ethiopia from Australia in the late 19th century (1895) by

Emperor Menilik the II when the king of Kings accepted the advice of the French railway engineer Mondon-Vidailet about the benefits of Eucalyptus. The major aim of the introduction of exotic trees like eucalyptus was to solve the critical shortage of fuel wood and construction materials in Addis Ababa and other towns of that time in the country. Since then, the tree is considered as multipurpose tree to the rural and the urban dwellers. Eucalyptus is now known as an immediate and for long period cash income source in the major eucalyptus growing areas of Ethiopia especially in the Amhara region.

In Ethiopia, the eucalyptus tree plantation for long periods,

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since the last century, was not reported with that it had got constraints due to invasive pests. However, since recently, like elsewhere, the tree crop is suffered due to pests and mainly due to invasive insect pests.

In Ethiopia, the Eucalyptus plantation mainly *Eucalyptus camaldulensis*, since recently, is found under threat due to an attack by the gall wasps. An invasive and that worldwide distributed on Eucalyptus tree species, the Blue Gum Chalcid (BGC) [*Leptocybe invasa* Fisher and La Salle] (Hymenoptera: Eulophidae) (Mendel et al., 2004)] was reported in Ethiopia on its host *Eucalyptus* species since 2000 (ICFR, 2011); since 2002 (Giliomee, 2011).

Today, more species have become invasive than at any other time in the past (Senthikumar and Thangapandian, 2013). This is the typical observed phenomenon in Ethiopia that such invasive species arrived on different plants-on crops and trees. Among these, the Blue Gum Chalcid causes severe injury to young foliage of mainly red river gum (*Eucalyptus camaldulensis*) by inducing galls on seedlings in nurseries and at fields, on saplings, in plantations, on coppiced shoots and even on the new shoots of old *Eucalyptus camaldulensis*. Mendel et al., (2004) reported that the wasp lays eggs in petiole and midrib of leaves and stems of young shoots of eucalyptus that leads to gall formation. Gall formation by *L. invasa* damages growing shoots tips and leaves of Eucalyptus, resulting in quicker abscission of leaves and drying up of shoots. The gall wasps have an adverse effect on their host by removal the nutrients and making galls on the plant tissue (Stone and Schonrogge, 2003). Heavy galling prevents further growth of the infested shoots (Karunaratne et al., 2010). Therefore, such wasps could be economically important insect pests in Ethiopia on the important Eucalyptus trees which at the moment that serves as an immediate cash source for farmers, other stakeholders and for members of broad community of those involved on eucalyptus plantation and production.

Having understand/consideration of / the danger situation appeared on the economical important Eucalyptus woodlot and plantation in Ethiopia, survey was initiated and conducted by tree pest researchers in the part of the major Eucalyptus growing areas of the country, as first phase, in the North & Northeast, Central part of the country: in the parts of Amhara, Tigray National Regional States, and in Addis Ababa city (where growing as an Urban Eucalyptus plantation) to determine the distribution and abundance of the Blue Gum Chalcid on its host Eucalyptus species in part of year 2016 and in year 2017.

During the survey tours, unfortunately, a new type of gall making wasp attack and damage symptom, which is with plenty of small galls on the blade of leaves on *Eucalyptus camaldulensis*, was observed in certain Eucalyptus growing places of Amhara and Addis Ababa administrative regions.

This new type of galls forming insect pest occurrence on *Eucalyptus camaldulensis* at first was observed in February 2017, in Kombolcha town, South Welo, that growing nearby the Borekena river. According to the attack and damage symptom exhibited on the eucalyptus leaves, (with plenty of

small galls on the leaves blade feature) is typical & similar with the Eucalyptus Gall Wasp (*Ophelimus maskelli*) attack and damage symptoms on the same host that described by Protasov et al., (2007) was observed. Heavy galling by *O. maskelli* results in premature shedding of the leaves, soon after the emergence of the wasp. The most distinctive characteristic of *Ophelimus maskelli* as compared with other congeners is the presence of the only a single seta on the sub marginal vein (Protasov et al., 2007). In addition to the field observation, on the samples attacked leaves of Eucalyptus collected to laboratory indicated that there is a new occurrence of an invasive wasp insect pest. So, this report is attempting to explain specifically on the newly insect wasp that arrived to the country, to Ethiopia, that observed in expressing itself with appearance of plenty of small galls on *Eucalyptus camaldulensis* blade leaves (Pic.1) and (Pic.2).

The *Ophelimus maskelli* (Ashmead) (Hymenoptera: Eulophidae), commonly known as the Eucalyptus Gall Wasp (EGW) is a serious gall -inducing pest of Eucalyptus which is native to New South Wales, Australia (Protasov et al., 2007). *Ophelimus maskelli* is one of the six serious pests that had been reported to invade the eucalyptus trees in the Mediterranean region (Protasov et al., 2007), (Mendel et al., 2007). It is further mentioned by these authors that "heavy infestations induce much galling in leaves, which results in widespread defoliation and loss of growth and vigor in susceptible trees. *Ophelimus maskelli*, a gall inducing pest of *Eucalyptus camaldulensis*, that accidentally introduced from Australia into the Mediterranean region, Africa and in North America in recently (in 2014). It is suggested that the probable cause of introduction into the Euro-Mediterranean areas, and the subsequent movement across the globe, is through trade of its host (Eucalyptus sp.). It is highly likely that *O. maskelli* will establish itself in new parts of the world via this method. In favourable conditions, *O. maskelli* populations can reach epidemic levels. As it is observed in the Mediterranean region, the entire leaf surface can be covered in small blister like galls ranging from a red-bruised colour to a yellow-green hue. Leaves bearing greater than 50 galls live considerable less in comparison to those without galls (Protasov et al., 2007). The same appearance symptoms with more numbers of galls on a leaf have been observed on *Eucalyptus camaldulensis* species during the survey tours in some parts of Amhara and Addis Ababa (Pic.1.).

Unlike the *Leptocybe invasa* the other gall forming insects viz. *O. eucalypti* (Gahan) and *Ophelimus maskelli* (Ashmead) have emerged as the main production constraints in recent times even in its native country, in Australia. From this information it looks that these two waspinsect pests are challenging their natural enemies even in their native place that was balanced the population of the insect pest wasps for long periods (Anonymous, 2011).

After we started survey trip for the assessment of the status of the Blue Gum Chalcid, in Amhara regional state, the situation on eucalyptus trees at the ground made us surprise and build more awareness on us that to conduct a systemic survey and to make closely observation on all growth stages

of the Eucalyptus tree species reaction to the new type of gall forming insect pest symptom during the tours in the planned part of the major Eucalyptus growing regions of the country.

2. Objectives

To determine the occurrence, distribution and abundance of Eucalyptus Gall Wasp (EGW) on major Eucalyptus growing areas of Amhara, Tigray and in Showa (Addis Ababa city where eucalyptus plantation grown as urban trees) as first phase tour to the country on this Gall making wasp on Eucalyptus.

To assess the economic importance of the wasp insect pests that are associated with different eucalyptus species and

To suggest research proposals for future intervention for the proper management of the determined once, the invasive insect pest of the Eucalyptus tree species, in the surveyed areas of the country.

3. Materials and Methods

Study area

The survey trip routes were followed the main vehicle roads to the regions where the eucalyptus trees growing as road and farm boundary, visiting tree nurseries, and woodlot plantation. Each eucalyptus plantation type was included to be surveyed. During the tour, a stop was made at about every 10 km or where ever one of the eucalyptus plantation type is grown and where plenty Eucalyptus tree plantations are available. The major eucalyptus species growing areas of the country are dominated mainly by two Eucalyptus species: *E. globules* and *E. camaldulensis*. Based on agro-ecology situations. Records had been taken on type and species of eucalyptus plantation, growth stage of the eucalyptus tree, altitude, latitude and longitude of the site where samples were taken.

Methods

In each stop, visual observation and assessment was made along a diagonal or X walk to record the present or absent of the Eucalyptus Gall Wasp (EGW), attack or damage symptom and level of infestation on the Eucalyptus tree species. During A stop was made, 5-10 eucalyptus trees were randomly selected and visited, assessed for the presence and/or/ absence of the newly occurred small sized galls attack symptoms on the leaf blades that made by the EGW. On the individual eucalyptus trees with galls were further assessed for numbers of leaves with type of galls, unopened and opened galls were also attempted to be counted. The opened gall symptoms could tell at the time of the survey that the BGC has more than one generation on its host. Samples of attacked leaves were collected from randomly selected *eucalyptus camaldulensis* and brought to Entomological Laboratory of Central Ethiopia Environment and Forest Research Center (CEEFRFC). The collected specimen was

kept in pour orated/ventilated/ polyethylene bags and kept in room temperature until adult wasps were emerged from the infested galls of the eucalyptus leaves. In the addition of the attack symptom observed on the field the emerged adult wasps were observed under stereomicroscope in the laboratory and was followed the Protasov et. al., (2007) description that was given to *Ophelimus maskelli* (Ashmead) and a comparison methods were used to determine the adult wasp species.

On *Eucalyptus camaldulensis* grown on most of the surveyed areas along the main roads of Amhara, Tigray and in sub city of Addis Ababa, as urban eucalyptus plantation, and on *Eucalyptus grandis* on some part of Tigray, Presence and/or Absence of EGW's attack symptom were recorded.

Materials used

GPS apparatus, magnifying lenses, sweep net, knife, scissor, ethanol 70%, plastic bags, raring cages, stereomicroscope, reference books and related written articles were used at field and in laboratory.

4. Results & Discussion

The Blue Gum Chalcid (BGC) causes severe injury to young foliage of mainly on red river gum (*Eucalyptus camaldulensis*) by inducing galls on seedlings in nurseries and at fields, saplings, in plantations, on coppiced shoots and even on the new shoots of old *Eucalyptus camaldulensis* trees. The wasp species distribution area in the surveyed areas of Amhara is large, starting from Atayie district (North Shoa) to West Gojam up to the Abay Gorge; in South and North Gonder (up to Chilga district to the west); In Tigray Region, from the Southern, (GraKahesu), Central (Adua & Aksum) to Northwest, Tahtaye Koraro district and also on the Urban *Eucalyptus camaldulensis* woodlots of Addis Ababa.

This paper is mainly focused on the newly arrived and causing attack and damage on *Eucalyptus camaldulensis* in Ethiopia. During the survey tours, a new type of gall making infestation symptom on *Eucalyptus camaldulensis* was accidentally observed. The new phenomenon of wasp attack symptom on eucalyptus plant part, the occurrence of the Eucalyptus Gall Wasp (*Ophelimus maskulli*), was at first observed and recorded in urban town on a one-year old coppiced *Eucalyptus camaldulensis* at Kombolcha town, adjacent to Borkena river. The Eucalyptus trees are grown at an altitude of 2218 m.a.s.l. N 08° 56.671' and E 038° 44. 522' in Kalu district South Welo, The different situation observed at Kombolcha, where it is In-land port town for import and export items and goods, is that the two gall making wasps attack symptoms, i.e, galls formed on the midribs of the leaves and galls on the leaf blades by the Blue Gum Chalcid and by the Eucalyptus Gall Wasp respectively. The symptoms were found together on the same single eucalyptus species, on *Eucalyptus camaldulensis*, even both attack symptoms on a leaf of a tree, the gall making symptom observed at Kombolcha town Kalu district in South Welo, on

one-year old coppiced eucalyptus woodlot plantation grown. This gall forming insect pest infestation symptom on Eucalyptus was for the first time observation in Ethiopia since February 2017. In the survey tour, after the Kombolcha town, more close observation was given to record for present or absent of the newly occurred insect pest attack symptom and damage extent on Eucalyptus.

After we started survey trip for the Blue Gum Chalcid, the situation at the ground made awareness for us that to be care of conduct a systemic survey and to make closely observation on all growth stages of the Eucalyptus trees during the tours in the planned part of the Eucalyptus growing regions of the country.

The newly observed galls forming feature were found on the blade of each leaf as it is observed on randomly selected coppiced of one-year old trees. Where it was observed the new type gall formation, it was attempted to count unopened and opened galls on leaves blades of 5 trees in each selected site. In the same manner, count of leaves with small but plenty galls on the blade of the leaf on the Eucalyptus Gall Wasp attack symptom were observed along the main road of at near- by Wechalie town (Ambasel district); at near-by Woldia town, (Guba Lafto district) and at near Kobo districts of South and North Welo administrative zones of Amhara Region. Similar attack symptom on the same Eucalyptus *camaldulensis* was observed in Addis Ababa City that grown as urban Eucalyptus trees (Table-1).

Sample of attacked Eucalyptus tree parts (leaves, twigs) by the gall making wasps were collected from the fields and kept in perforated polyethylene (for aeration) bags brought to laboratory from few districts of Amhara and Addis Ababa and kept in rearing cages for adult wasp to be emerged. The incidence and the severity of *O. maskelli* might be in its host *eucalyptus camaldulensis* is growing region, where in the leaves attacked and damaged is very high, for instance, it was counted 291 galls /180 cm² up to 216 galls /25 cm² of leaf area which might indicate that the insect pest is found in Ethiopia, in its most preferable environments. Leaves, twigs were collected and observed under stereo-microscope at the Entomology laboratory of Central Ethiopia Environment and Forest Research Center (CEEFR) and the species assessment was made with comparison methods and with the help of references of description of *Ophelimus maskelli* given by Protasov, et al, (2007).

The understanding of the biology and ecology for *O. maskelli* is still limited as Biological Control on Eucalyptus Plantation (Bi CEP) mentioned. As it is mentioned, the Eucalyptus Gall Wasp (EGW) have got five wasp development phases that coincide with gall development, consisting of three larval instars, a non-feeding pupal stage and adult. The adult emerges by cutting a circular hole in the gall wall close to the plane of the leaf (Protasov et al., 2007) All these phases had been proceeds as it was observed at the fields on the Eucalyptus trees plant parts and on those attacked plant part samples leaves collected and brought with plenty galls, after sometimes adult wasps were made an exit hole and emerged and found in the plastic bags which were

kept in laboratory at room temperatures.

Though the *Ophelimus maskelli* arrival to the country, to Ethiopia, not yet determined but since it is mentioned that the probable cause of introduction into the Euro-Mediterranean areas, the wasp could be disseminated easily with trade materials and with the help of winds (Verde et.al.; 2011), and also as indicated in Bi CEP & its products. The Kombolcha town, as being one of the import and export inland-port of goods of the country which found along the main vehicles and tracks road from Djibouti Republic (main sea port) to Ethiopia and from Ethiopia to Djibouti, so the trade import activities could be much possible. So, if we observe and consider the main transportation line corridor for importing goods from Abroad, via Djibouti, which is the main sea-port for Ethiopia, and land port to the central and northern part of the country, so this logistic situation and where relatively eucalyptus plantation found in more densely along the main road from Djibouti to the Kombolcha town in Kalu district, South Welo administrative region. The high infestation level of this invasive insect pest (Pic.1), and dissemination rate that shown it might allow that *Ophelimus maskelli* introduced to the country with imported good. In African content, unlike the BGC, the *Ophellimus maskelli* was reported in three countries: in Morocco, Algeria (Caleca (2010) and Tunisia only so far (Roger, et al. 2015). The newly occurred and dictated gall making wasp on *E. camalduensis*, might be a first report in east Africa.

5. Forward and Conclusions

For both wasps that occurred as invasive insect pests required Integrated Insect Pest Management Strategy. However, for the recently arrived and at the moment the infestation area coverage of the infested eucalyptus are not much and is found on one to two years *eucalyptus camaldulensis* young trees at backyard, as road and farm boundaries only. At the moment the EGW infestation not dictated at forest nurseries or on young seedlings that could be done chemical insecticides spray or other substance used as insecticides like Kaolin, as it is used in other countries for preventing its attack on young Eucalyptus at nurseries (Verde et al. 2011). The immediate action against the EGW on this time is by Silviculture practices and Physical control options. Sanitation, pruning and burning of infested Eucalyptus tree species plant parts by EGW i.e. avoiding plant parts that are infested from the Eucalyptus woodlot niches and use them for fuel. Since the EGW infestation coverage at the moment is small (Fig.1.), should go for campaign public work for the physical preventing option with a sort of rural and urban dwellers and growing of the Red River Gum (*Eucalyptus camalduensis* /Key Bahir Zaf / communities in each infested location.

In Ethiopia, at the moment it is found in some of the surveyed major *Eucalyptus camaldulensis* species growing areas physical control measures as an alert to act is important. The country has the same eucalyptus species and environmental situation in other parts of the country and the

new insect pest could be disseminated to other parts of the country where eucalyptus are plenty and domestic quarantine measures should be considered on this newly arrived and one of the invasive and devastating insect pest on Eucalyptus.

The introduction of natural enemies of the invasive insect pest to the country should be considered as the IPM component.

Table 1. The Eucalyptus Gall Wasp (EGW) (*Ophelimusmaskelli* occurrence on *Eucalyptus camaldulensis* in Amhara & AA Regions year, 2017

NN	Region	District	Location/ locality	GPS reading / Tree stand Orientation					Eucalyptus Leaves on Growth stage of the tree -on	Wasp's infestation status
				Altitude	Latitude	Longitude	P reading	UTM reading		
1	Amhara	Kalu	Kombolcha /kebele11	1995	11°5.308'	39°41.401'	37P0575359	UTM1225841	1 year old	Very high
2	Amhara	Wechalie	Weleko Mai	1778	11°30.221'	039°36.718'	37P0566738	UTM1271745	1-2 year old	Very high
3	Amhara	Wechalie	Kekewa	2000	11°19.042'	039°40.514'	37P053687	UTM1251158	1-2 year old	High
4	Amhara	Wechalie	DebaWeha	1554	11°34.730'	039°39.709'	-	-	1-2 year old	high
5	Amhara	GubaLafto	Weldiya	1932	11°50.018'	039°36.021'	37P0566483	UTM1308229	1-2 years	high
6	Amhara	Rayana Kobo		1576	11°58.941'	039°38.594'	37P0570027	UTM1324684	1 year old	high
7	Addis Ababa city	Lafto Nefas silk	Kebel 12	2226	08°56.931'	038°44.163'	37P0495339	UTM0989899	On new shoots of > 10 years old	high
8	Addis Ababa city	LaftoNefas Silk	Kebel 12	2249	08°56.864'	038°44.503'	37P0471607	UTM0989083	On new shoots of > 6 years old t Eucalypt .trees	high

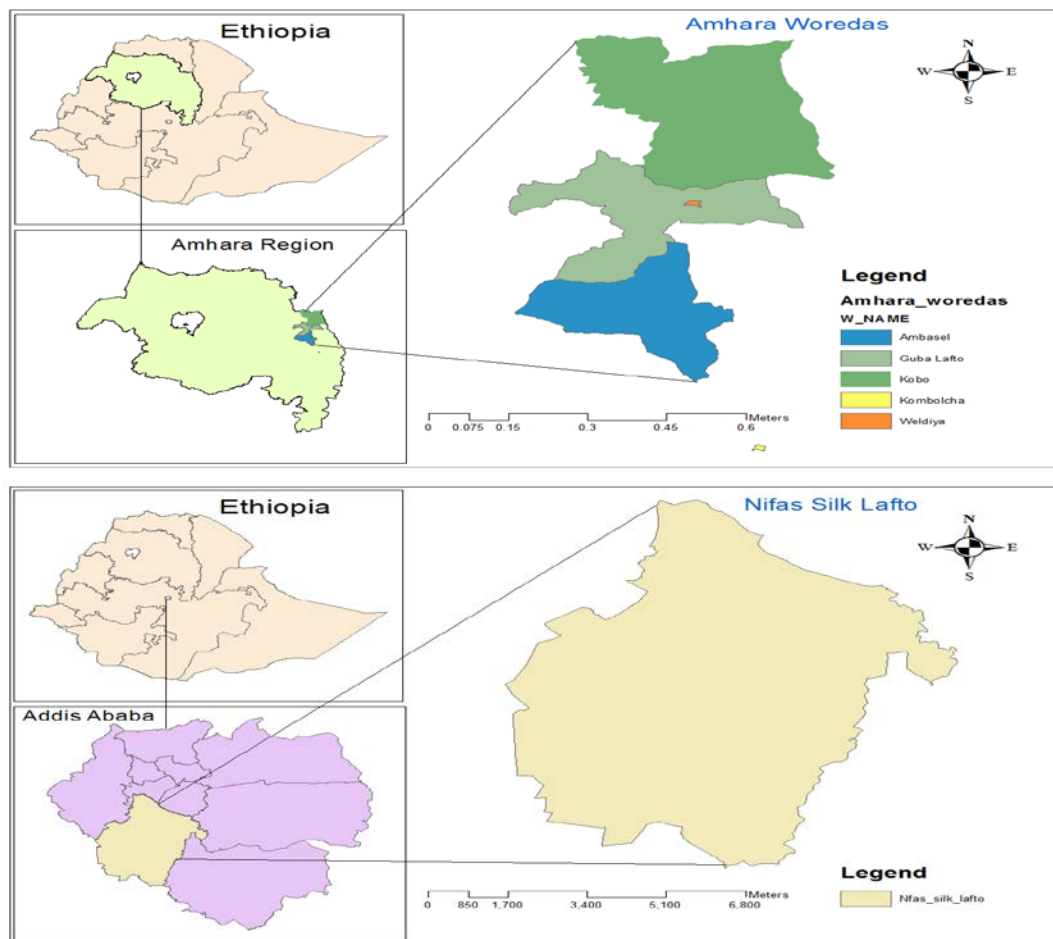


Figure 1. Maps of the Amhara Regional State and Addis Ababa City, Ethiopia with their districts where currently the Red River Gum tree species (RRG), *Eucalyptus camaldulensis* is infested by the invasive Eucalyptus Gall Wasp [(*Ophelimusmaskelli*) (Hymenoptera: Eulophidae)]. Current distribution of the Eucalyptus Gall Wasp (EGW) in Ethiopia, 2017



Picture 1. The attack symptom of Eucalyptus Gall Wasp (*Ophelimusmaskelli*) (Hymenoptera: eulophidae) on Eucalyptus camaldulensis leaves at Kombolcha town, south Welo, the pictures below taken on 02, March, 2017



Picture 2. The *Ophelimus maskelli* (Ashmead) infestation and making of galls on leaf blade of *E. camaldulensis* starts from the edge part of the mid rib near to petiole then covers the whole leaf blade, and also galls of both species frequently occur on the same leaf



Picture 3. The emerged adults *O. maskelli* from the infested & swelling blade leaves of *E. camaldulensis* that were sample collected from Amhara region and kept in laboratory

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