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# Journal of Parasitology and Vector Biology

Table of Content: Volume 6 Number 5 May 2014

## ARTICLES

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- Phototropism of sand flies species (Diptera: Psychodidae) collected in a rural locality in Central Morocco** 66  
Khadija Lahouiti, El Ouali Lalami Abdelhakim , Asmae Hmamouch and Khadija Bekhti
- Prevalence of *Schistosoma mansoni* and geo-helminthic infections among patients examined at Workemeda Health Center, Northwest Ethiopia** 75  
Tadesse Hailu and Mulat Yimer

Full Length Research Paper

## Phototropism of sand flies species (Diptera: Psychodidae) collected in a rural locality in Central Morocco

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An inventory of a year was achieved using two traps techniques (light and sticky trap) in Oulad Aid (center of Morocco), a focus of cutaneous leishmaniasis (CL), to understand better the phototropism of circulating species of the sandflies dominance according to their physiological states (total number of sandflies collected are to be given). The most abundant species were respectively *Phlebotomus papatasi* (50.52%), *Phlebotomus sergenti* (24.7%), *Phlebotomus perniciosus* (9.69%), *Phlebotomus longicuspis* (5.54%), *Sergentomyia falax* (5.22%), *Sergentomyia minuta* (3.64%), *Sergentomyia antenata* (0.4%) and *Sergentomyia dreyfussi* (0.2 %). With sticky traps, *P. papatasi* constituted 59% of collected samples against 23% for *P. sergenti*, 12% for *P. perniciosus* and 6% for *P. longicuspis*. However with light traps, phototropism of *P. sergenti* was high and represented 56% of collected samples against 36% for *P. papatasi* and only 4% for *P. perniciosus* and *P. longicuspis*. The trap technique influenced the dominance of females collected according to their physiological state. Non engorged females were dominant (77.73%) when sticky traps were used but gorged and gravid females were, respectively dominant (32.62 and 21.98%) when light traps were used. Statistical analysis showed that significantly more number of sand flies were obtained using sticky traps, compared with that of light traps. Sticky traps were found to be effective, as the sand flies entering the dwellings either for blood meal or mating got trapped, while light traps yielded relatively lesser number of sand flies species. Perhaps the sand flies which are influenced by the light were attracted towards the light traps. This information may be necessary for designing intervention measure and evaluation of the impact on sand fly prevalence in a CL focus area.

**Key words:** Sand flies, Psychodidae, phototropism, leishmania, Morocco.

### INTRODUCTION

Leishmaniasis are endemic in Morocco and remain a great health problem which represents the second most common vector-borne disease in the Mediterranean region.

On a large scale, worldwide, the leishmaniasis infects between 1.5 and 2 million people each year (World Health Organization, 2007). It is estimated that leishmaniasis

disease has an undesirable morbid effect corresponding to 2.34 million years of life (World Health Organization, 2010). In Morocco, the vectors involved in the transmission of the disease are: *Phlebotomus (larroussius) ariasi* Tonnoir 1921 (Rioux et al., 1984a; Rhajaoui, 2011) and *Phlebotomus (Larroussius) perniciosus* Newstead 1911 (Guernaoui et al., 2005). These species are found throughout the Rif mountains and lowlands of pre-Rif, where visceral leishmaniasis due to *Leishmania (Leishmania) infantum* is abundant (Nejjar et al., 1998); *Phlebotomus (larroussius) longicuspis* Nitzulescu 1930 is considered as the vector of sporadic cutaneous leishmaniasis due to *L. (Leishmania) infantum* in the semi-arid belt (Dereure et al., 1991) and even in the arid belt (Dereure et al., 1986).

*Phlebotomus (Paraphlebotomus) sergenti* Parrot 1917 was found infested by *Leishmania (Leishmania) tropica* (Ajaoud et al., 2013), responsible for the dry skin which is very recurrent in the semi-arid belt in Western slope of the Atlas from the province of Taza to Essaouira on the Atlantic coast (Guilvard et al., 1991); *Phlebotomus (Phlebotomus) papatasi* Scopoli 1786 is dominant in the zoonotic cutaneous leishmaniasis focus due to *Leishmania (Leishmania) major* localized in the arid south of the Atlas mountains that extend from the province of Jrada east to Tata province west (Rioux et al., 1986a; Boussaa, 2008; Guernaoui, 2011).

Morocco is also jointly involved in leishmaniasis control programme which is based on the detection and monitoring of vectors' density. Moulay Yacoub, located about 10 km from the city of Fez, is monitored for skin focus (Fellah et al., 2007). For implementing effective vector control strategy to suppress the leishmania infection, the investigations were carried out on the seasonal abundance and behavior of sandflies, mainly the females, depending on the nature of the technique used in the capture in the province of Moulay Yacoub, which is a known focus of cutaneous leishmaniasis (Lahouiti et al., 2013).

## MATERIALS AND METHODS

### Studied area

Douar Ouled Aid is located (34° 05' N, 4° 45' W, 345 m MSL) about 35 km to the N-N-east of the city of Fez. It is part of the province of Moulay Yacoub known as a new "microfocus" of human cutaneous leishmaniasis due to *L. tropica* (Fellah et al., 2007). The area is rural and is located on one of South Rif hills and has about 709 inhabitants; the majority of houses are built with clay and straw. Regions depend on rainfed agriculture and breeding livestock

which are considered the only activity for the population of the region. Vegetation is dominated by *Olea europaea*, *Zizyphus lotus*, *Eucalyptus sp*, *Cylindropuntia imbricata* and *Opuntia sp*.

### Sandfly collection

Light traps "C. D. C. Miniature Light Trap" (Mulhern, 1942; Sudia and Chamberlain, 1988) was used for sandfly collection both indoor and outdoor (Figure 1). This device is composed of a motor assuring the functioning of a small fan to maintain a continuous low intensity suction, an ampoule of 0.3 A, with a transparent plastic cylinder inside which the fan-motor-lamp is located, a cage covered with a very fine mesh cloth piece and a very flat metal cover that covers the whole device and protects the camera from rain and projections. Insects attracted by the lights will be drawn and collected in the collection bottle. Light traps are placed from 6 pm to 8 am. They are placed inside the house and stables at an average height of 2 m. Sticky traps made of sheets of white A4 paper (21 x 29.7 cm) smeared with castor oil (Rioux et al., 1967) were placed upright in the walls of human dwellings (Figure 2) and stables entries (Figure 3). The oiled sheets are held by a thread (Figure 2) or maintained by a rigid support (Figure 3).

### The sticky traps placed from 6 pm to 8 am

The traps are placed in many habitats, intra-domestic (Figures 1 and 2) and peri-domestic (Figure 3) in the cow's, donkey's, horse's and sheep's stables. Period of capture lasted all night, traps were placed at the site in the previous evening (6 pm) and collected in the subsequent morning (8 am). Sand flies obtained in the collection, using light and sticky traps, were transferred in a vial containing 70% alcohol, using fine brush and again preserved in 95% absolute alcohol. The samples were then cleaned with a Marc-André solution before being mounted in Canada Baum (Floch and Abonnec, 1957). Taxonomic identification is based on different morphological criteria described by Abonnec (1972) and Niang et al. (2000), such as cibarium and pharynx in both male and female, spermathecae in female and the armature of genitalia in male.

### Statistical analyses

Results were statistically performed by the software R using the Pearson's chi-squared test comparing percentages. For the entire test, the significance level was 0.05.

## RESULTS

The results shown in this paper included data from the entomological survey undertaken in Douar Ouled Aid during a year between April, 2011 and March, 2012 to show the particular phototropism of sand fly species and of females according to their physiological states. Data were subjected for statistical analysis, using a software

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R and the Pearson's chi-square test for comparing percentage. For the entire test, the significance level is 0.05.

A total of 3,064 sand flies were obtained during the study, of which 87.8% (N = 2690) were obtained from sticky traps and the remaining (12.2%; N = 374) from light traps (Table 1). The number of sand flies captured using sticky traps was greater than the number collected using light traps. The difference was statistically significant between the two traps ( $\chi^2 = 1750, 606, p\text{-value} < 2.2e^{-16}$ ). Of the total sand flies caught, the sand flies of the genus *Phlebotomus* were predominant in the sticky trap collections (86.9%), compared to that of light trap collections (13.1%). Similarly, sand flies of the *Sergentomyia* collected using sticky traps were 95.9% and light traps were 4.1%, indicating a statistically significant difference between the efficacy of the traps in sand fly collection ( $\kappa^2 = 18.9182, p\text{-value} = 1.364 \times 10^{-05}$ ).

In both types of trap collection, male sand flies were predominant (Table 2) that is, 82% male in sticky trap collections and 61.7% male in light trap collections. However, *Sergentomyia fallax* species were the only females captured using both types of traps. On the contrary, *Sergentomyia antennata* males were abundant in the collections. The difference was statistically significant between the two traps ( $\kappa^2 = 2.7778, p\text{-value} = 0.09558$ ).

### Species composition

Among the total collections (N = 3064), *P. papatasi* was represented at 50.5%. The other species of sand flies obtained in order of abundance are as follows; *P. sergenti* (24.7%), *P. perniciosus* (9.7%) and *P. longicuspis* (5.5%). The difference was statistically significant between these species ( $\kappa^2 = 52, p\text{-value} = 2.995 \times 10^{-11}$ ). Phlebotomine's collection was carried out twice a month during one year. The traps were placed from 6 pm to 8 am. The morpho-anatomical identification of species was based on the identification of key sand flies (Abonnec, 1972; Niang et al., 2000). The result shows the number of males (M) and females (F) for each species and for each type of trap.

By examining the distribution of species according to the type of trap, we have noticed that with sticky traps, *P. papatasi* was dominant at 59% ( $\kappa^2 = 706.2147, p\text{-value} < 2.2 \times 10^{-16}$ ) followed by *P. sergenti* (23%) ( $\chi^2 = 308443, p\text{-value} < 2.2 \times 10^{-16}$ ), *P. perniciosus* (12%) ( $\chi^2 = 216.5634, p\text{-value} < 2.2 \times 10^{-16}$ ) and *P. longicuspis* (6%) ( $\chi^2 = 70.2229, p\text{-value} < 2.2 \times 10^{-16}$ ) (Figure 4). However, with light traps (Figure 5), *P. sergenti* was collected at 56% ( $\chi^2 = 15.3725, p\text{-value} = 8.826 \times 10^{-05}$ ) followed by *P. papatasi* at 36% and *P. perniciosus* and *P. longicuspis* at 4%.

The physiological states of the females are given in Table 3. The sticky trap and light traps yielded about 70.44% of

**Table 1.** Distribution and abundance of sand flies inventoried for each trap.

Species	Sticky traps	Light traps
<i>P. papatasi</i>	1416	132
<i>P. sergenti</i>	553	204
<i>P. perniciosus</i>	284	13
<i>P. longicuspis</i>	157	13
<i>S. falax</i>	157	3
<i>S. minuta</i>	106	6
<i>S. antennata</i>	14	1
<i>S. dreyfussi</i>	3	2
Total	2690	374

**Table 2.** Distribution and abundance of sand flies inventoried for each trap according to their sex.

Species	Sticky traps	Light traps
<i>P. papatasi</i>	1208 M	72 M
	208 F	60 F
<i>P. sergenti</i>	483 M	130 M
	70 F	74 F
<i>P. perniciosus</i>	266 M	12 M
	18 F	1 F
<i>P. longicuspis</i>	131 M	10 M
	26 F	3 F
<i>S. falax</i>	0 M	0 M
	157 F	3 F
<i>S. minuta</i>	103M	6 M
	3F	0 F
<i>S. antennata</i>	14 M	1 M
	0 F	0 F
<i>S. dreyfussi</i>	2 M	0 M
	1 F	1 F
Total	2690	373

non engorged females, 19.64% for engorged females and 9.90% for gravid females. The difference is statistically significant between the three physiological states of females ( $\chi^2 = 8.2439, p\text{-value} = 0.01621$ ). However, with each trap, this percentage changes, with sticky traps at 77.73% of harvested females which are



**Table 3.** Abundance of female *Phlebotomus* species inventoried in each trap according to their physiological state.

Species	Sticky traps	Light traps
	125 FN	34 FN
<i>P. papatasi</i>	71 GS 12 G	18 GS 8 G
	57 FN	24FN
<i>P. sergenti</i>	2 GS 11 G	27 GS 20 G
	15 FN	1 FN
<i>P. perniciosus</i>	0 GS 3 G	0 GS 1 G
	23 FN	1 FN
<i>P. longicuspis</i>	3 GS 2 G	1 GS 1 G
	153 FN	3 FN
<i>S. falax</i>	1 GS 3 G	0 GS 0 G
	3 FN	0 FN
<i>S. minuta</i>	0 GS 0 G	0 GS 0 G
	0 FN	0 FN
<i>S. antenata</i>	0 GS 0 G	0 GS 0 G
	1 FN	1 FN
<i>S. dreyfussi</i>	0 GS 0 G	0 FGS 1 G

Non engorged (FN), engorged females without (GS), gravid (G), normal females (NF).

non engorged, 15.87% of the females which are engorged and 6.39% which are pregnant. With light traps, 45.39% of collected females are non engorged, 32.62% are engorged and 21.98% are pregnant. The difference between the three physiological states females with these types of traps is statistically significant ( $\chi^2 = 90.0431$ ,  $p$ -value  $< 2.2 \times 10^{-16}$ ).

*P. sergenti* and *P. papatasi* were the two common species in this study; we have investigated the female's distribution by types of traps according to their physiological states. The results (Figure 6) shows that 6% of attracted *P. papatasi* specimens are pregnant females,

34% are females engorged with blood and 60% are neither pregnant females nor engorged. These percentages were almost the same with light traps (Figure 7). However *P. sergenti* females had a clear trap preference depending on their physiological conditions; with sticky traps (Figure 8), 81% of females were normal, 16% of females were engorged and 3% were pregnant but with light traps (Figure 9), 38% of females were gorged with blood, 28% were pregnant and 34% were normal females.

Phlebotomine's collection was carried out twice a month during one year. The traps were placed from 18 pm to 8 am. The morpho-anatomical identification of species was based on the sand flies key identification (Abonnec, 1972; Niang et al., 2000). The result shows the distribution of *P. papatasi* females collected by light trap according to their physiological states: non engorged (FN), engorged females without (GS) and gravid (G).

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## DISCUSSION

The results reported in this paper shows for the first time the distribution of sand fly species and the physiological state of females according to the techniques of traps used for the collection in this semi-arid rural area of Douar Oulad Aid characterized as an anthropic niche of *L. tropica* (Rhajaoui et al., 2004; Fella et al., 2007). The density of sand flies captured by sticky traps (87.8%) is higher than the density of sand flies collected by the light



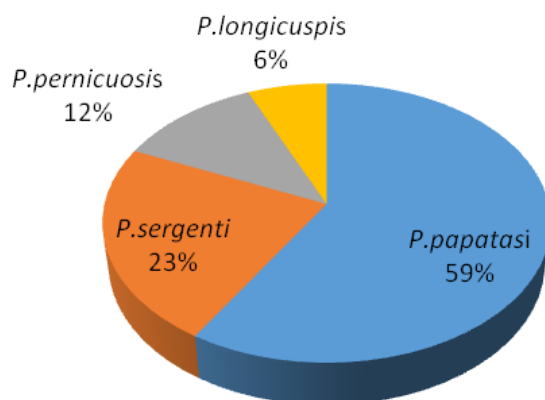
**Figure 1.** Light traps (A and B) inside houses.



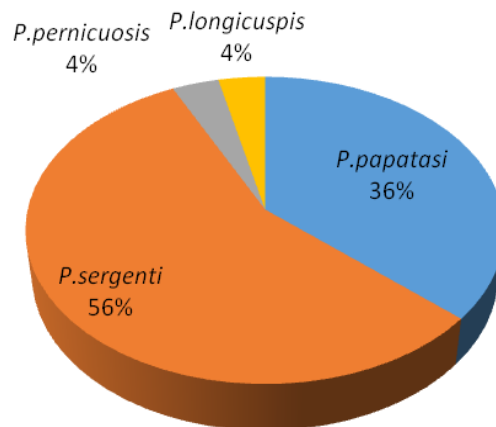
**Figure 2.** Sticky traps inside the houses.



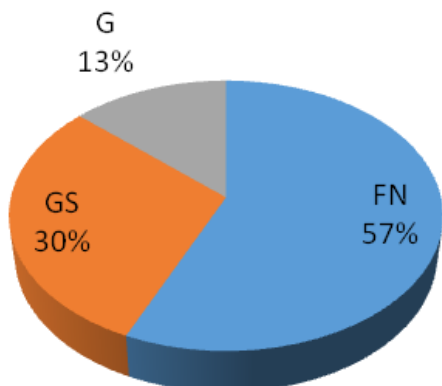
**Figure 3.** Sticky traps (A and B) inside the stables.



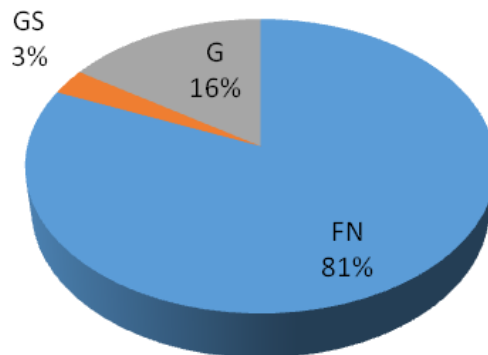
**Figure 4.** Abundance of species of *Phlebotomus* genus collected by sticky traps (ST).



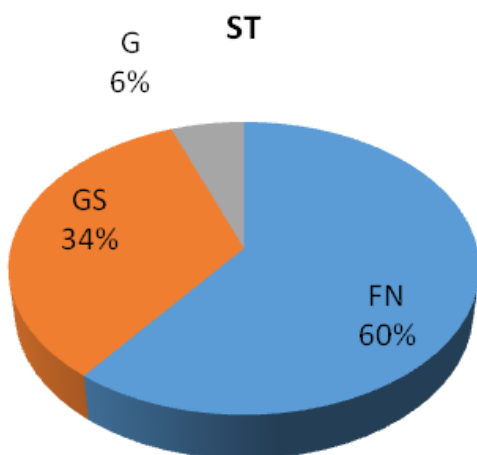
**Figure 5.** Abundance of species of *Phlebotomus* genus collected by light traps (LT).



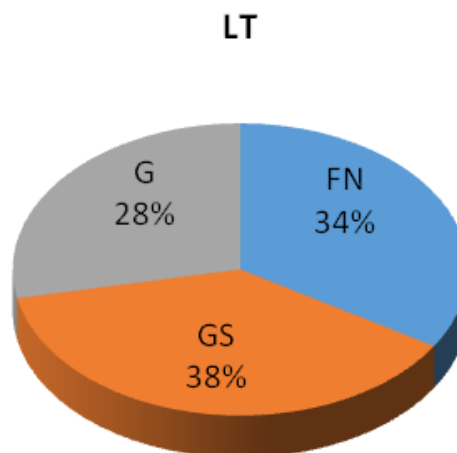
**Figure 6.** Abundance of female *P. papatasi* collected by light traps (LT) according to their physiological states FN (normal females), GS (engorged females) and G (gravid females).



**Figure 8.** *P. sergenti* females' abundance by sticky traps (ST) according to their physiological states FN (normal females), GS (females engorged) and G (pregnant females).



**Figure 7.** Abundance of female *P. papatasi* by sticky traps (ST) according to their physiological states FN (normal females), GS (females engorged), G (gravid females).



**Figure 9.** *P. sergenti* females abundance by light traps (LT) according to their physiological states FN (non engorged), GS (engorged females), G (pregnant females).

traps (12.2%). With both traps, *Phlebotomus spp* was collected at 89.46% while *Sergentomyia* was collected at 10.54%. *Phlebotomus spp* is the most abundant, they have been also reported by several authors (Bailly-Choumara et al., 1971; Rioux et al., 1984; Dereure et al., 1991; Raspail et al., 2002; Guernaoui et al., 2000; Boussaa, 2008; Faraj et al., 2013) as the only vectors implicated in the transmission of leishmaniasis in Morocco. Sticky traps captured more of both species of the *Phlebotomus* (86.9%) and *Sergentomyia* genus (94.5%). *Sergentomyia* species (*S. falax*, *S. minuta*, *S. antenata*, *S. dreyfussi*) phototropisms seems undeveloped (5.5%) since its species are not attracted by light

light traps. These results confirm the effectiveness of the use of oiled paper as a good sampling and monitoring of sand flies populations technique (Boukraa et al., 2010). The sticky traps have the advantages of not being repellents, being very viscous; they are also soluble in alcohol which facilitates insects' retrieval. However sand flies collected using sticky traps are damaged and the taxonomic study by morpho-anatomical identification can be difficult.

For the entire collection and within the *Phlebotomus* genus, *P. papatasi*, *P. sergenti*, *P. perniciosus* and *P. longicuspis* are the circulating species in the heart of central Morocco, with *P. papatasi* dominating at 56.38%,

followed by *P. sergenti* dominating at 27.3%. This result confirms the work of Lahouiti (2013), who reported the dominance of *P. papatasi* in this province and those of Rioux et al. (1984) which reported the widespread that the dominance of a species of sand fly in an outbreak of leishmaniasis depends on used trap technique. It also shows that phototropism of *P. sergenti* species is higher compared to *P. papatasi*, *P. perniciosus* and *P. longicuspis* that are captured only at 4%, with light traps contrary to 12% when sticky traps is used. Blood sucking females are the leishmaniasis vectors, the relationship between sand fly-leishmania is close and the study of the distribution by type of trap of females according to their physiological state may be interesting to the extent in which we want to study the vector's infestation or the sand flies trophic power. Our study showed that the sample is composed of 70.44% of normal females (neither gravid nor engorged), with 19.64% of engorged females and 9.90% of pregnant females. However, the abundance of females according to their physiological state in each of the types of traps showed that sticky traps attracts more normal females (77.73%) than engorged females (15.87%) and pregnant females (6.39%), while light traps attracted 32.62% of engorged females and 21.98% of pregnant females. This original result shows the effectiveness of the use of the technique of light traps in the collection in order to have more females engorged with blood which are necessary to perform more specific studies. The same study is applied to the two most abundant species in this semi-arid outbreak which are *P. papatasi* and *P. sergenti*. The physiological state of *P. papatasi* females is not affected by light, the percentage of distribution of normal females, females engorged and gravid females is, respectively 57 to 60, 30 to 34 and 6 to 13% for sticky and light traps which is probably explainable by the lack of infectious activity of this species in this location whose vector is *P. sergenti*. The latter species is confirmed as being the only vector of *L. tropica* MON 101 by the works of Rhajaoui (2004) and Fellah et al. (2007) in this area and demonstrated infested by *L. tropica* by Ajouad et al. (2013). We have shown dominance and a high phototropism for the species of *P. sergenti*; females also have a net density difference according to the used traps and to their physiological states. Indeed, females engorged and gravid females are attracted to light traps, respectively 38% (GS) and 28% (G), while the sticky traps set at 81% that of normal females and only 3% are females engorged with blood which likely confirms the infectious activity of *P. sergenti* in this focus.

## Conclusion

We have shown that the calculated dominance in an

outbreak of leishmaniasis depends on the trap chosen. We have also shown that in the locality of Oulad Aid (central Morocco), *P. papatasi* may be dominant if we use sticky traps and *P. sergenti* may be dominant if we use light traps. We have also shown that the sticky traps are effective and therefore, monitoring the population during surveillance sticky traps could be used. While the light traps though yielded a relative lower number of sand flies species, these traps are used in identification, which would also be used to know the species abundance and distribution.

## Conflict of Interest

The authors declare that they have no conflict of interests.

## REFERENCES

- Abonnet E (1972). Les phlébotomes de la région éthiopienne (Diptera, Psychodidae). Paris: ORSTOM, p 289. Multigr. (Mémoires ORSTOM; 55).
- Ajaoud M, Es-sette N, Hamdi S, El-Idrissi AL, Riyad M, Lemrani M (2013). Detection and molecular typing of *Leishmania tropica* from *Phlebotomus sergenti* and lesions of cutaneous leishmaniasis in an emerging focus of Morocco. Parasit. Vectors 6:217.
- Sudia WD, Chamberlain RW (1988). Battery-operated light trap, an improved model. J. Am. Mosq. Control Assoc. 4(4):536-538.
- Bailly-choumara H, Abonnet E, Pastre J (1971). Contribution à l'étude des phlébotomes du Maroc (Diptera, Psychodidae): données faunistiques et écologiques. Cahiers ORSTOM. Med. Parasitol. Entomol. Series 9(4):431-460.
- Boukraa S, Boubidi SC, Zimmer JY, Francis F, Haubruge E, Alibenali-Lounaci Z, Doumandji S (2010). Surveillance des populations de phlébotomes (Diptera: Psychodidae), vecteurs des agents responsables des leishmanioses dans la région du M'Zab-Ghardaïa (Algérie). Entomol. Faunistique 63(3):97-101.
- Boussaa S (2008). Epidemiology of leishmaniasis in Marrakesh area, Morocco. Effect of urbanization on sandfly distribution and molecular characterisation of there populations. <http://www.biomedsearch.com/sci/Epidemiology-leishmaniasis-in-Marrakesh-area/0000493621.html>
- Dereure J, Rioux JA, Gallego M, Périères J, Pralong F, Mahjour J, Saddiki H (1991). Leishmania tropica in Morocco: infection in dogs. Trans. R. Soc. Trop. Med. Hyg. 85(5):595
- Faraj C, Adlaoui E, Ouahabi S, El Kohli M, El Rhazi M, Lakraa L, Ameer B (2013). Distribution and bionomic of sand flies in five ecologically different cutaneous leishmaniasis foci in Morocco. ISRN Epidemiol. <http://dx.doi.org/10.5402/2013/145031>.
- Fellah H, Rhajaoui M, Ouahabi S, Belghiti D, Lyagoubi M (2007). Occurrence of Human Cutaneous Leishmaniasis in Zouagha My Yacoub Province (Morocco). Int. J. Agric. Biol. 9(1):197-198.
- Floch H, Abonnet E (1957). Diptères phlébotomes de la Guyane et des antilles Françaises. Faune de l'Union Française 14:1-207.
- Guernaoui S, Pesson B, Boumezzough A, Pichon G (2005). Distribution of phlebotomine sandflies, of the subgenus *Larrousius*, in Morocco. Med. Vet. Entomol. 19:111-115.
- Guilvard E, Rioux JA, Gallego M, Pralong F, Mahjour J, Martinez-Ortega E, Dereure J, Saddiki A, Martini A (1991). *Leishmaniatropica* au Maroc. III - Rôle vecteur de *Phlebotomus sergenti*. A propos de 89 isolats. Annal. Parasitol. Hum. Comp. 66:96-99.

- Lahouiti K, El Oualilalami A, Maniar S, Bekhti K (2013). Seasonal fluctuations of phlebotomines sand fly populations (Diptera: Psychodidae) in the Moulay Yacoub province, centre Morocco: Effect of ecological factors. *Afr. J. Environ. Sci. Technol.* 7:1028-1036.
- Leger N, Depaquit J (2001). Les phlébotomes et leur rôle dans la transmission des leishmanioses. *La Revue Française des Laboratoires* 338:41-48.
- Mulhern, T.D. 1942. New Jersey mechanical trap for mosquito surveys. Circular 421, 1-8 New Jersey Agricultural Experimental Station, Rutgers University, New Brunswick, New Jersey
- Nejjar R, Lemrani M, Malki A, Amarouch H, Benslimane A (1998). Canine leishmaniasis due to *Leishmania infantum* MON-1 in Northern Morocco. *Parasite* 5:325-30.
- Niang AA, Geoffroy B, Anget G, Trouillet L, Killick-kendrick R, Hervy JP, Brunhes J (2000). Les phlébotomes d'Afrique de l'ouest. Logiciel d'identification et d'enseignement l'I.R.D., Montpellier.
- Rhajaoui M (2011). Les leishmanioses humaines au Maroc : une diversité nosogéographique; Human leishmaniasis in Morocco: A nosogeographical diversity. *Pathologie Biologie* 59:226-229
- Rhajaoui M, Fellah H, Pratlong F, Dedet FJ, Lyagoubi M (2004). Leishmaniasis due to *Leishmania tropica* MON-102 in a new Moroccan focus. *Trans. R. Soc. Trop. Med. Hyg.* 98(5):299-301.
- Rioux JA, Golvan YJ, Croset H, Houin R, Juminer B, Bain O, Tour S (1967). Ecologie des leishmanioses dans le Sud de France. Echantillonnage. *Ethologie. Ann. Parasitol. Hum. Comp.* 42:561-603.
- Rioux JA, Guilvard E, Dereure J, Lanotte G, Denial M, Pratlong F, Serres E, Belmonte A (1986a). In: Rioux JA (ed.), *Leishmania*. Infestation naturelle de *Phlebotomus papatasi* (Scopoli, 1786) par *Leishmania major* MON-25. A propos de 28 souches isolées dans un foyer du Sud marocain. In *Leishmania. Taxonomie et Phylogénèse. Applications Eco-épidémiologiques. Coll. Int. CNRS/INSERM/OMS.* 471-480.
- Rioux JA, Jarry DM, Lanotte G, Maazoun R, Killick-Kendrick R (1984a). Ecologie des leishmanioses dans le sud de la France. 18. Identification enzymatique de *Leishmania infantum* Nicolle, 1908, isolé de *Phlebotomus ariasi* Tonnoir, 1921 spontanément infesté en Cévennes. *Annal. Parasitol. Hum. Comp.* 59:331-333.
- Rioux J A, Rispaï P, Lanotte G, Lepart J (1984). Relations Phlébotomes bioclimats en écologie des leishmanioses. Corollaires épidémiologiques. L'exemple du Maroc. *Bull. Soc. Bot. Fr.* 131:549-557.
- Rispaï IP, Dereure J, Jarry D (2002). Risk Zones of Human Leishmaniasis in the Western Mediterranean Basin. Correlations between Vector Sand Flies, bioclimatology and Phytosociology. *Mem. Inst. Oswaldo Cruz.* 97(4):477-83.
- Velez ID, Pratlong F, Denial M, Lardi M, Moreno G, Serres E, Lanotte G, Rioux JA (1986b). La leishmaniose viscérale autochtone au Maroc méridional. Présence de *Leishmania infantum* MON-1 chez le Chien en zone présaharienne. In *Leishmania. Taxonomie et Phylogénèse. Applications Eco-épidémiologiques, International colloquium CNRS/INSERM/OMS, July 1984. Institut Méditerranéen d'Etudes Epidémiologiques et Ecologiques, Montpellier, France.* 421-425.

Full Length Research Paper

## Prevalence of *Schistosoma mansoni* and geo-helminthic infections among patients examined at Workmeda Health Center, Northwest Ethiopia

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*Schistosoma mansoni* and geo-helminths are considerable medical and public health problems in Ethiopia. However, information is limited on the epidemiology of these parasitic infections in different areas, it is very important to plan effective prevention and control measures. Therefore, the aim of this study was to determine the prevalence of *S. mansoni* and geo-helminthic infections among patients examined at Workmeda Health Center. Institution based retrospective cross sectional study was conducted to determine the prevalence of *S. mansoni* and geo-helminthic infections among patients from September 2012 to August 2013. A total of 604 participants (56.6% males and 43.4% females) within the age range of six to eighteen were included. A single stool sample was collected and processed using direct microscope. The analysis of the generated data revealed that the overall prevalence of intestinal parasites infection was 32%. The prevalence of *S. mansoni* and hookworm species were 7.3 and 20.7%, respectively. Patients in the age range of 10 to 14 years had higher (14.7%) rate of infection. Prevalence of *S. mansoni* (12%) infection was higher in the age range 10 to 14 years. High prevalence of *S. mansoni* and hookworm species need periodic deworming programme and health education urgent to reduce morbidity and mortality.

**Key words:** Prevalence, *Schistosoma mansoni*, geo-helminths, Workmeda.

### INTRODUCTION

Intestinal parasites affect human's health in many parts of the world. Their problem is magnificent, particularly in developing nations (WHO, 1981). Several reports showed that the overall high prevalence of intestinal helminths in the world mainly attributed to infections emanating from environmental contamination by human excreta. Thus, helminthic infections as a whole can be viewed as the best

indicators of the sanitation level of a community (Mahfouz et al., 1997).

The most prevalent and important helminths in developing countries are Schistosomes (Rozendaal, 1998) and geo-helminths also called soil-transmitting helminthes (STHs) including *Ascaris lumbricoides*, *Trichuris trichiura* and Hookworms (WHO, 1962). Recent global prevalence

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estimate shows that *A. lumbricoides* infect 1.221 billion, *T. trichiura* infect 795 million and hookworm infect 740 million people worldwide (Silva et al., 2003).

Schistosomiasis also remains one of the most prevalent parasitic diseases in the world and is endemic in 74 tropical countries worldwide. Approximately, 500 to 600 million people are at risk of schistosomal infection, and 80% of the 200 million people are infected worldwide live in sub-Saharan Africa where *Schistosoma mansoni* and *Schistosoma haematobium* are widely distributed (WHO, 2002; Davis et al., 2003). Schistosomiasis is also endemic in many parts of Ethiopia. The intestinal form of schistosomiasis caused by *S. mansoni* is widely distributed in the country, however, the urinary form caused by *S. haematobium* is limited to some lowland areas of Ethiopia (Lo et al., 1988; Tedla et al., 1998).

Intestinal schistosomiasis and geo-helminths infections are the major causes of morbidity and mortality in different parts of Ethiopia (Akilu et al., 1986; Leykun, 2001) causing a series of public health problems such as malnutrition, anaemia, and growth retardation as well as higher susceptibility to other infections (Silva et al., 1997). Although many studies previously conducted in Ethiopia indicated that the distribution of different intestinal parasites on different altitudes in different community groups such as preschool children, school children and other groups confined to camps and refugees, the prevalence of *S. mansoni* and STHs infections was not well addressed in different parts of Ethiopia including our study area. In addition, the scarcity of reports on the distribution and prevalence of *S. mansoni* and STHs infections in Ethiopia promoted investigation of the conditions in Northwest Ethiopia.

Therefore, the aim of this study was to determine the prevalence of *S. mansoni* and STHs infections among patients examined at Workmeda Health Center, Northwest Ethiopia. The research finding could provide baseline data on the distribution and prevalence of intestinal parasites and assisting in proposing strategies to protect parasitic infections.

## MATERIALS AND METHODS

### Study population, area and period

Institution based retrospective cross sectional study was conducted to determine the prevalence of *S. mansoni* and geo-helminths among patients examined at Workmeda Health Center, Jawe Woreda, Northwestern Ethiopia from September 2012 to August 2013. The area has an elevation of about 1000 to 1050 m above sea level. The study subjects engaged in this study were 604 clinically suspected cases of intestinal parasite infection within age range 6 to 18 who visited Outpatient Department (OPD) of Workmeda Health Center. Eligible study subjects for the study were those patients clinically suspected of intestinal parasitosis and had stool examination from 6 to 18 years. Children less than 5 years and adults greater than 18 years with diarrhea and suspected of intestinal parasitosis were excluded from this study.

### Clinical and laboratory diagnosis

One year retrospective data of intestinal parasitosis were collected from Workmeda Health Center. In this Health Center, direct stool examination of well-prepared smears is used in confirming the presence of Schistosomiasis and other intestinal parasites infection. In Ethiopia, detection of intestinal parasites in stool is conducted according to a standard operating procedure (SOP) in each health center throughout the country. The direct smear method is done by mixing 2 mg of stool with either one drop of saline (diarrhea) or iodine (formed) on a slide, covered with cover slide and sealed first with low power, then high power (WHO, 2004). Therefore, for this study objective, one year (September 2012 to August 2013) of *S. mansoni* and Geo-helminths data, Socio-demographic information and environmental related factors at Workmeda Health Center in October 2013 had been collected by reviewing the patient's card and laboratory log book.

### Statistical methods

Data were entered in to excel and transported to SPSS. Analysis was performed by SPSS version 16 statistical software package. Frequency and percentage were calculated for the study variable. Chi-square, p-value and two tail Fisher's exact test were used to calculate and determine significance. In all statistical tests, the differences were considered to be statistically significant if p-value less than 0.05.

### Ethical consideration

The department ethical review committee of Microbiology, Immunology and Parasitology, College of Medicine and Health Science, Bahir Dar University approved the project. The researchers obtained informed consent from the Workmeda Health Center.

## RESULTS

### Socio-demographic characteristics of study subjects

A total of 604 clinically suspected intestinal parasitosis cases who attended at Workmeda Health Centre were enrolled in this study. The mean age of the attendants was 12.24 years with a standard deviation (SD) of 4.05 ranging from 6 to 18. There were more males (56.6%) than females (43.4%). Nearly 9% of the cases were under 7 years, 56% of the cases were between 7 and 14 years, the rest 35% were great than 14 years old. And majority of the study group were greater than 10 years old (Table 1).

The overall prevalence of parasitic infection was 32%. Of which, hookworm species accounted for (20.7%) parasites infection followed by *S. mansoni* (7.3%) (n=604) (Table 2). About 3.6% of the cases were co-infected with hookworm species and *S. mansoni* (n = 193). However, no triple, quadruple and multiple infections were found (Table 2).

### Prevalence of *S. mansoni* and geo-helminths

The overall prevalence of *S. mansoni* and geo-helminths



**Table 1.** Prevalence of intestinal parasitosis infections based on their socio-demographic characters in Northwest Ethiopia [n, %].

Result	Age			Sex		Address	
	6-9	10-14	15-18	M	F	Urban	Town
Positive	45 (25.4)	92 (42.6)	56 (26.5)	114 (33.3)	79 (30.2)	183 (31.9)	10 (33.3)
Negative	132 (74.6)	124 (57.4)	155 (73.5)	228 (66.7)	183 (69.8)	391 (68.1)	20 (66.7)
Total	177 (29.3)	216 (35.8)	211 (34.9)	342 (56.6)	262 (43.4)	574 (95)	30 (5)
$\chi^2$ , P		29.09, 0.04		8.53, 0.481		7.839, 0.550	

**Table 2.** Distribution of intestinal parasites in relation with their address in Northwest Ethiopia [n, %].

Result	Address						
	Asech	Cimida	Dire	Kava	Workmeda	Wobo	Total
Hookworm	22 (17.6)	24 (19.2)	13 (10.4)	45 (36)	8 (6.4)	13 (10.4)	125 (4.8)
<i>A. lumbricoides</i>	0 (0)	1 (33.3)	1(33.3)	1 (33.4)	0 (0)	0 (0)	3 (.11)
<i>T. trichiura</i>	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
<i>S. mansoni</i>	3 (8.1)	9 (24.3)	8 (21.6)	14 (37.9)	1 (2.7)	2 (5.4)	37 (19.2)
<i>Strongyloides stercoralis</i>	1 (16.7)	2 (33.3)	1 (16.7)	2 (33.3)	0 (0)	0 (0)	6 (31)
<i>H. nana</i>	0 (0)	0 (0)	0 (0)	2 (66.7)	1 (33.3)	0 (0)	3 (.11)
Hookworm + <i>S. mansoni</i>	1 (14.2)	0 (0)	3 (42.9)	3 (42.9)	0 (0)	0 (0)	7 (36.3)
Hookworm + <i>A. lumbricoides</i>	0 (0)	1 (100)	0 (0)	0 (0)	0 (0)	0 (0)	1 (0.5)
<i>Entamoeba histolytica</i>	1 (12.5)	0 (0)	0 (0)	5 (62.5)	0 (0)	2 (25)	8 (41.5)
<i>Giardia lamblia</i>	0 (0)	0 (0)	2 (66.7)	1 (33.3)	0 (0)	0 (0)	3 (1.55)
Total positive	28 (5.4)	37 (35.9)	28 (35.9)	73 (29.3)	10 (33.3)	17 (26.2)	185 (30.6)
Total	79 (3.1)	103 (17)	78 (12.9)	249 (41.2)	30 (5)	65 (10.8)	604
$\chi^2$ , P				47.622, 0.366			

was 30%. The prevalence of *S. mansoni*, hookworm species, *A. lumbricoides* and *T. trichiura* in this study was found to be 7.3, 22, 0.7, and 0%, respectively (n = 604). The prevalence of *S. mansoni* which was 2.8% found in Kava was high followed by 1.8% in Dire Kebele. Similarly, the prevalence of hookworm species (7.9%) was high in Kava Kebele, followed by 4.1% in Cimida (Table 3).

### Prevalence of *S. mansoni*

The prevalence of *S. mansoni* obtained from rural and urban was 34 (5.6%) and 10 (1.7%) (n=604), respectively but not statistically associated (Table 4). About 8.2% of male (n= 342) and 6.1% of female (n= 262) cases were found to be infected with *S. mansoni* (Table 4). The prevalence of *S. mansoni* infection was high (12%) in age group 10 to 14 (n = 216), followed by 5.1% in age group 6 to 9 (n = 177). *S. mansoni* infection was statistically associated with high prevalence in males and age group 10 to 14 (Table 4).

## DISCUSSION

The prevalence of *S. mansoni* and geo-helminths among school age segments of the population of Jawe Woreda

was determined. The overall prevalence of parasitic infection in this study was 32% and the infection rates were very high in children age range of 10 to 14. Prevalence of parasitic infections obtained in the present study was comparable with those previously reported (34.4%) in South Western Ethiopia (Awole et al., 2003) and 36.6% in North Western Tanzania (Mazigo et al., 2010). In contrast to the present study, high prevalence of parasitic infection (50.6%) was reported in Gorgora Town, Northwest Ethiopia (Assefa et al., 2013).

In Ethiopia, most *S. mansoni* infections and transmission sites are in agricultural communities along streams between 1300 and 2000 m altitude (Kloos et al., 1988). The prevalence of *S. mansoni* (7.3%) in the present study was comparable with 10.1% in North West Ethiopia (Zinaye et al., 2013), and 5.6% in North Western Tanzania (Mazigo et al., 2010), but higher than 3% in South Western Ethiopia (Awole et al., 2003). In contrast to the present study, high prevalence of *S. mansoni* infections, 73.7% in Southern Ethiopia (Terefe et al., 2011), 27.1% in Northern Ethiopia (Dejenie et al., 2009), and 23.1% in South Cote De voire (Coulibaly et al., 2013) was reported.

The low prevalence of *S. mansoni* in this study may be due to the direct diagnosis method applied in the Ethiopian health system. The best diagnosis method for

**Table 3.** Prevalence of *S. mansoni* and geo-helminths in Northwest Ethiopia [n, %].

Result	Address						Total
	Asech	Cimida	Dire	Kava	Workmeda	Wobo	
Hookworm	23 (3.8)	25 (4.1)	16 (2.7)	48 (7.9)	8 (1.3)	13 (2.2)	133 (22)
<i>A. lumbricoides</i>	0 (0)	2 (0.3)	1 (0.2)	1 (0.2)	0 (0)	0 (0)	4 (0.7)
<i>T. trichuria</i>	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
<i>S. mansoni</i>	4 (0.7)	9 (1.5)	11 (1.8)	17 (2.8)	1 (0.2)	2 (0.3)	44 (7.3)
Total positive	27 (4.50)	36 (6)	28 (4.6)	66 (10.9)	9 (1.5)	15 (2.5)	181(30)
Total cases	80 (13.3)	102 (16.9)	78 (12.9)	246 (40.7)	31 (5.1)	67 (11.1)	604

**Table 4.** Distribution of *S. mansoni* infection based on patients age, sex and address in Northwest Ethiopian [n, %].

Result	Total	Age			Sex		Address	
		6-9	10-14	15-18	M	F	Rural	Urban
Positive	44 (7.3)	9 (5.1)	26 (12)	9 (4.3)	28 (8.2)	16 (6.1)	34 (5.6)	10 (33.3)
Negative	560 (92.7)	168 (94.9)	190 (88)	202 (95.7)	314 (91.8)	246 (93.9)	540 (94.1)	20 (66.7)
Total	604	177 (29.3)	216 (35.8)	211 (34.9)	342 (56.6)	262 (43.4)	574 (95)	30 (5)
$\chi^2, P$		10.527, 0.005			4.156, 0.028		0.708, 0.400	

*S. mansoni* is the Kato Katz test which is not used as a routine diagnosis method in Ethiopia (Endris et al., 2012). On the other hand, the prevalence of intestinal parasites in the present study may be attributable to walking on bare foot, unhygienic conditions, insufficient provision of safe water, in appropriate utilization of latrine, crossing the river when going to their field work and use river water for washing, swimming and playing. The magnitude of the problem emphasizes the need to take immediate intervention measures. Combined mass chemotherapy and focal snail control using primary health care systems may have an effect on the prevalence and intensity of parasitic infections in the study area.

The distribution of *S. mansoni* infection among age groups showed that there was high prevalence of *S. mansoni* (12%) in age groups 10 to 14. This study was in agreement with previous study reports (28.5%) in South West Ethiopia (Mengistu et al., 2007), 28.53% in North West Ethiopia (Zinaye et al., 2013), and 30.71% in Northern Ethiopia (Assefa et al., 2013) which showed high prevalence of *S. mansoni* in age group 10 to 14.

The prevalence of *S. mansoni* infection was high among males than females. A similar high prevalence of *S. mansoni* in males than females was reported previously in South West Ethiopia (Dejenie et al., 2008). This might be due to males are mostly engaged to manipulate the farming activity so that they might be exposed to river water in washing, crossing and swimming more frequently than females. In addition, there are two main rivers (Burabur and Asewe) which are used for a source of water in the study area. Males do not have any problem to swim and wash in these rivers, but females are culturally influenced by the community not to swim and

to swim and wash in the rivers.

Among the geo-helminths, the prevalence of hookworm species (22%) was high in this study. Similar previous high hookworm species prevalence (25.2%) in Tanzania (mazingo et al., 2010) and 28.4% in Southern Ethiopia (Kloos et al., 1988) was reported. In contrast to this study, lower hookworm prevalence reports 12% in South Western Ethiopia (Awole et al., 2003) and 8.2% in North West Ethiopia (Endris et al., 2012).

Though, multiple infections were common in Ethiopia (Mengistu et al., 2007), only 1 to 2 species of parasites per individual were observed in this study and majority of the co-infections were between *S. mansoni* and hookworm species. Prevalence of co-infection of *S. mansoni* and hookworm (3.6%) in this study was in agreement with previous 7.4% in North Ethiopia (Kloos et al., 1988), and 74.6% in Eastern Uganda (Moirra et al., 2012). This may be because of the higher prevalence of each parasites and/or their similar mode of transmission which favors dual infections and could also be the different stool examination method.

## Conclusion

This study showed that high prevalence of hookworm species and *S. mansoni* were an important health problem in Jawe Woreda North West Ethiopia. Factors such as low awareness of schistosomiasis, swimming, washing, bathing and crossing the river water, and walking on bare foot might be associated risk factors for hookworm species and *S. mansoni* infection in the study area. This calls for periodic deworming programme to reduce

reduce transmission, worm burden and morbidity. Deworming for both *S. mansoni* and STHs should be supplemented with improved sanitation and access to clean water, appropriate health education and environmental measures to have a lasting impact on transmission. The impact of each measure would be maximized through a health education program directed to school age children in particular, and to communities in general.

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## Conflict Interests

The authors declare that there is no conflict of interests regarding the publication of this article.

## REFERENCES

- Aklilu L, Demisse M, Bahta M (1986). Parasitological survey of Addis Ababa and Debre Zeit school children with special emphasis on Bilharziasis. *Ethiop. Med. J.* 6:1-7.
- Assefa A, Dejenie T, Tomass Z (2013). Infection prevalence of *Schistosoma mansoni* and associated risk factors among schoolchildren in suburbs of Mekelle city, Tigray, Northern Ethiopia. *Mek. Univ.* 5(1):174-188.
- Awole M, Gebre-Selassie S, Kassa T, Kibru G (2003). Prevalence of Intestinal Parasites in HIV-Infected adult Patients in Southwestern Ethiopia. *Ethiop. J. Health Dev.* 17:71-78.
- Coulbaly JT, N'Gbesso YK, Knopp S, N'Guessan NA, Silue KD, Van Dam GJ, NGoran EK, Utzinger J (2013). Accuracy of Urine Circulating Cathodic Antigen Test for the Diagnosis of *Schistosoma mansoni* in Preschool-Aged Children before and after Treatment. *PLOS Neg. Trop. Dis.* 7(3):e2109.
- Davis A, Cook C, Zumla A (2003). *Schistosomiasis: Manson's Tropical Diseases*, London. pp. 1431-1469.
- Dejenie T, Asmelash T (2008). Impact of irrigation on the prevalence of intestinal parasite infections with emphasis on schistosomiasis in Hintallo-Wejerat, North Ethiopia. *Ethiop. J. Health Sci.* 18(2):33-38.
- Dejenie T, Asmelash T, Teferi M (2009). Intestinal Helminthes Infections and Re-Infections with Special Emphasis on Schistosomiasis *Mansoni* in Waja, North Ethiopia. *Meke. Univ.* 1(2):4-16.
- Endris M, Tekeste Z, Lemma W, Kassu A (2012). Comparison of the Kato-Katz, Wet Mount, and Formol-Ether Concentration Diagnostic Techniques for Intestinal Helminth Infections in Ethiopia. *ISRN Parasitol.* 2012:5.
- Kloos H, Lo CT, Birrie H, Ayele T, Tedla S, Tsegay F (1988). Schistosomiasis in Ethiopia. *Soc. Sci. Med.* 26(8):803-827.
- Leykun J (2001). Soil Transmitted Helminthic Infection and *S. mansoni* in School Children from Chilga District, North West Ethiopia. *Ethiop. J. Health Sci.* 1:79-87.
- Lo CT, Kloos H, Hailu B (1988). *Schistosomiasis: The Ecology of Health and Disease in Ethiopia*. Addis Ababa., EMPDA Press. pp. 196-207.
- Mahfouz AAR, El-Morshedy H, Farghaly A, Khalil A (1997). Ecological determinants of intestinal parasitic infections among pre-school children in an Urban Squatter Settlement of Egypt. *J. Trop. Ped.* 43:341-334.
- Mazigo HD, Ambrose EE, Zinga M, Bahemana E, Mnyone LL, Kweka EJ, Heukelbach (2010). Prevalence of intestinal parasitic infections among patients attending Bugando Medical Centre in Mwanza, north-western Tanzania: a retrospective study. *Tanzan. J. Health Res.* 12:2.
- Mengistu A, Gebre-Selassie S, Kassa T (2007). Prevalence of intestinal parasitic infections among urban dwellers in southwest Ethiopia. *Ethiop. J. Health Dev.* 21(1):12-17.
- Moira APD, Jones FM, Wilson S, Tukahebwa E, Fitzsimmons CM, Mwatha JK, Bethony JM, Kabatereine NB, Dunne DW (2012). Childhood schistosome and hookworm co-infections: effects of treatment on IgE responses against parasite allergen-like proteins and immunity to re infection. *Infect. Immun.* doi:10.1128/IAI.00748-12
- Rozendaal JR (1997). *Vector Control Methods for use by Individuals and Communities*. WHO, Geneva, No. 337-356.
- Silva NRDe, Brooker S, Hotez PJ, Montresor A, Engles D, and Savioli L (2003). Soil-transmitted helminth infections: updating the global picture. *Trends Parasitol.* 19(12):547-551.
- Silva NRDe, Guyatt HL, Bundy DA (1997). Morbidity and mortality due to ascaris-induced intestinal obstruction. *Trans. R. Soc. Trop. Med. Hyg.* 91(1):31-36.
- Tedla S, Tilahun G, Burie H (1998). *Parasitology. Schistosomiasis in Ethiopia and Eritrea, 2<sup>nd</sup> ed.* Institute of Pathobiology., AAU. pp. 9-28.
- Terefe A, Shimelis T, Mengistu M, Hailu A, Erko B (2011). *Schistosomiasis mansoni* and soil-transmitted helminthiasis in Bushulo village, southern Ethiopia. *Ethiop. J. Health Dev.* 25(1):46-50.
- World Health Organization (WHO) (1962). *Soil transmitted helminthes*, WHO Tec Rep ser, Geneva, No. 277.
- World Health Organization (WHO) (1981). *World Health Organization Scientific Group Intestinal protozoa and helminths infection*, WHO Tech Rep Ser. 666, Geneva No 7-43.
- World Health Organization WHO (2002). *Prevention and Control of Schistosomiasis and Soil-Transmitted Helminthiasis*. WHO, Technical Report Series Geneva.
- World health Organization (WHO) (2004). *Schistosomiasis and intestinal parasites unit division of control of tropical diseases*. WHO, Training manual on diagnosis of intestinal parasites, Geneva.
- Zinaye T, Yeshambel B, Amare GH, Beyene M, Meseret W, Getnet A, Misganaw M, Afework K (2013). Epidemiology of intestinal schistosomiasis and soil transmitted helminthiasis among primary school children in Gorgora, Northwest Ethiopia. *Asian Pac. J. Trop. Dis.* 3(1):61-64.



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