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**The Republic of the Union of Myanmar  
Ministry of Natural Resources and Environmental Conservation  
Forest Department**



**Integrating Suitable Habitat Protection and Behavioral Observations for  
Asian Elephant Conservation: Towards an Effective Reinforcement  
Program  
(Part 3 – Effect of Semi-captive Elephants' Personality on The Interaction  
with Wild Elephants)**



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## **Integrating Suitable Habitat Protection and Behavioral Observations for Asian Elephant Conservation: Towards an Effective Reinforcement Program**

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### **Abstract**

To better support conservation actions such as species conservation translocation programs, understanding the biotic and abiotic habitat needs, intra-specific relationships and basic biology of the target species is fundamental. However, such information is still limited, especially regarding the endangered mega-fauna, Asian elephants (*Elephas maximus*) and this may also lead to the failure of conservation translocation. This study investigates the role of personality traits in shaping the behavioral interactions between semi-captive Asian elephants (*Elephas maximus*) and their wild counterparts, focusing on conflict, mingling, and mating behaviors. Building on insights from animal personality research, such as the influence of personality on translocation success and survival outcomes, we analyzed questionnaire data from mahouts to identify behavioral patterns among semi-captive elephants. A semi-structured questionnaire survey comprising 42 questions was conducted from February to April 2022 to investigate the social behavior, spatial movements, and environmental interactions of semi-captive elephants, based on the expertise of mahouts. Administered in the local language, the survey assessed elephants' tendencies for solitude, sociability, mingling, and interactions with wild counterparts through binary Yes/No responses. The study included 140 female and 130 male elephants, aged 4 to 78 years (median: females 18 years, males 15 years), residing in natural habitats. A total of 270 mahouts, with a median experience of three years (1 month to 26 years), independently provided ratings to minimize bias. Our findings revealed a significant association between the trait of aggression and the likelihood of engaging in conflicts with wild elephants, particularly males, likely due to the predominance of male wild elephants in the area. Conversely, the trait of sociality was linked to a higher tendency for mingling with wild elephants of both sexes, emphasizing the benefits of social behavior, as supported by previous studies on social species. This research underscores the importance of incorporating personality assessments into conservation strategies, particularly for managing interactions between semi-captive and wild elephants. It contributes to the growing body of literature on the ecological and conservation significance of animal personality.

**Keywords:** *Elephas maximus*, Conspecific interaction, Personality traits, Behavioral Ecology, Conservation Strategy

**အာရှဆင်ထိန်းသိမ်းစောင့်ရှောက်ရေးအတွက် အကျိုးသက်ရောက်မှုကောင်းသော ဆင်များ  
တောတွင်းလွှတ်ပေးခြင်း အစီအစဉ်တစ်ခုဖြစ်ပေါ်စေရန်အလို့ငှါ သင့်လျော်သော  
စားကျက်နေရာ ခန့်မှန်းတွက်ချက်ခြင်းနှင့် အပြုအမူပိုင်းဆိုင်ရာလေ့လာတွေ့ရှိချက်များအား  
ပေါင်းစည်းအသုံးပြုခြင်း**

ဒေါက်တာနှင်းနန္ဒာ၊ ဒုတိယတိရစ္ဆာန်ဆေးကုမှူး  
မြန်မာ့သစ်လုပ်ငန်း

### **စာတမ်းအကျဉ်း**

ဇီဝမျိုးစိတ်များကို ထိန်းသိမ်းစောင့်ရှောက်ရန်အလို့ငှါ နေရာရွှေ့ပြောင်းချထားခြင်း ကဲ့သို့သော ထိန်းသိမ်းစောင့်ရှောက်ရေးလုပ်ငန်းစဉ်များကို ပိုမိုကောင်းမွန်စွာ ပံ့ပိုးဆောင်ရွက် နိုင်ရန်နှင့် အောင်မြင်သောရလဒ်များရရှိနိုင်ရန်အတွက် သက်ရှိသတ္တဝါများအရဖြစ်စေ၊ ပတ်ဝန်း ကျင် အနေအထားအရ ဖြစ်စေလိုအပ်သော စားကျက်မြေများ၊ ရွှေ့ပြောင်းမည့် တိရစ္ဆာန်မျိုးစိတ် များ အချင်းချင်း အပြန်အလှန်ဆက်ဆံရေးနှင့် ၎င်းတို့၏ အခြေခံဇီဝကမ္မဖြစ်စဉ်များအကြောင်းကို ကောင်းစွာသိနားလည် ထားရန် အရေးကြီးလှသည်။ သို့သော်ငြားအဆိုပါအချက်အလက်များမှာ နည်းပါးနေသေးလျက်ရှိပြီး အထူးသဖြင့် မျိုးသုဉ်းနိုင်သည့် အန္တရာယ်ကြုံတွေ့နေရသော အာရှ ဆင်များ ထိန်းသိမ်းစောင့်ရှောက်ရေးတွင် အရေးတကြီးလိုအပ်နေသည်။ အဆိုပါလိုအပ်ချက်ကို ဖြည့်ဆည်းရန်ရည်သန်၍ ပဲခူးတိုင်းဒေသကြီးအတွင်း တောဆင်ကျက်စားရာနေရာများတွင် ပျံ့နှံ့နေထိုင်လျက်ရှိသော မြန်မာ့သစ်လုပ်ငန်း၊ သစ်ထုတ်ရေးဌာနပိုင်ဆိုင်မှုများ၏ အကျင့်စရိုက် များကို စစ်တမ်းကောက်ယူခြင်းနည်းအား အသုံးပြုလျက် စားကျက်အတွင်း တောဆင်နှင့် ရွှေ့ပြောင်းနေရာချထားမည့် အိမ်ဆင်များအကြား ဖြစ်ပေါ် နိုင်သည့်အပြန်အလှန်ဆက်ဆံရေးကို ခန့်မှန်းတွက်ချက်ခြင်း ဆောင်ရွက်ခဲ့ပါသည်။ သစ်ထုတ်ရေးဌာနမှ ဆင်ဦးစီး(၂၇၀)ဦးနှင့် မေးခွန်း အမေးအဖြေပြုလုပ်ကာ ၎င်းတို့တာဝန်ယူ စောင့်ရှောက်ရသော ဆင်များ၏ အကျင့်စရိုက်၊ တောဆင်များနှင့် ကြုံတွေ့ခဲ့ရသော အတွေ့အကြုံများကို စစ်တမ်းကောက်ယူခဲ့ပါသည်။ ဆင် အထီးများကို ရန်လိုတတ်သော အမူအကျင့်ရှိသည့် မည်သည့် ဆင်ထီး/မကိုမဆို တောတွင်း လွှတ်ပေးခြင်းအစီအစဉ်တွင် ထည့်သွင်းမည်ဆိုပါက တောဆင်နှင့် ရန်ပြုသည့် အဖြစ်အပျက်များ ပိုမို ဖြစ်ပွားနိုင်ချေရှိပြီး ၎င်းအားစတင်ချဉ်းကပ်လာသည့် မည်သည့် ဆင်အထီး/အမ ကိုမဆို ပြန်လည်လက်သင့်ခံတွဲသော ဆင်များကို အသုံးပြုမည်ဆိုပါက တောဆင်များနှင့် သင့်မြတ် နိုင်ချေပိုမိုကောင်းမွန်ကြောင်း တွေ့ရှိရပါသည်။ အဆိုပါတွေ့ရှိချက်အား မြန်မာ့ဆင် ထိန်းသိမ်း စောင့် ရှောက်ရေး စီမံချက်ပါဆင်များအား တောတွင်းပြန်လည်လွှတ်ကာ တောဆင်ကောင်ရေ လျော့နည်းလာမှုအား ကာကွယ်မည့် အစီအစဉ်တွင် အသုံးပြုခြင်းဖြင့် ကောင်းမွန်သော ရလဒ်များ ကို ရရှိစေမည့် အထောက်အပံ့တစ်ရပ် ဖြစ်လာမည်ဖြစ်ပါသည်။

# **Integrating Suitable Habitat Protection and Behavioral Observations for Asian Elephant Conservation: Towards an Effective Reinforcement Program**

## **(Part 3 – Effect of Semi-captive Elephants’ Personality on The Interaction with Wild Elephants)**

### **1. Introduction**

Behavior is critical in species conservation, influencing survival, reproduction, and ecosystem dynamics. Key behaviors, such as foraging, mating, and predator avoidance, directly affect an individual's ability to adapt to changing environmental conditions (Caro, 2007), while social interactions like communication, cooperation, and competition shape population and ecosystem stability (Huchard et al., 2016). Disruptions to social structures can cascade through ecosystems, impacting other species and processes (Estes et al., 2011). Behavioral consistency, described as personality, further affects dispersal (Cote et al., 2010), reproductive success (Boon et al., 2007), and responses to environmental changes (Dingemanse et al., 2004). Understanding behavior is essential for designing conservation strategies and addressing challenges in translocations, such as dispersal, learning, foraging, and social interaction issues, which can affect adaptation and survival (Berger-Tal et al., 2020).

In the context of Asian elephants, behavior is particularly significant, as 24–29% of the population is managed by humans (Jackson et al., 2019). Mahouts and handlers play a vital role in semi-captive elephant care, improving health, reproduction, and overall well-being (Crawley et al., 2021). For example, elephants in tourism settings with frequent handler interactions showed reduced stress levels, measured by fecal glucocorticoid metabolites (Brown et al., 2020). Handlers’ knowledge, based on daily observations, contributes significantly to understanding animal behavior and supporting conservation and welfare. Studies across species, such as zoo-housed elephants (Williams et al., 2019), laboratory rats (Renner and Renner, 1993), and captive reptiles (Whittaker et al., 2021), demonstrate the value of leveraging handlers’ expertise for advancing animal care, conservation strategies, and research. By integrating these insights, conservation programs can enhance the welfare and survival of species in both captive and wild environments.

### **2. Research Objectives**

This study aims to support future conservation strategies for Asian elephants by examining their behaviors, and suitable habitat conditions in the Bago Yoma region, in Myanmar. In a landscape facing challenges such as deforestation, human-elephant conflict, and poaching, the Myanmar government has implemented initiatives like a 10-year logging ban, ranger patrols, and efforts to restore wild elephant populations using semi-captive elephants. To contribute to these conservation efforts, this study investigates behavioral factors influencing interactions between wild and semi-captive elephants. The research addresses the role of semi-captive elephant personality traits in these interactions. It hypothesizes that personality traits, such as sociability and aggressiveness of the semi-captive elephants, influence interaction outcomes when they encounter their wild counterparts.

### **3. Materials and Methods**

The Bago Yoma Region, situated in the Southern Central part of Myanmar, and the northern edge of the Yangon Region (E 94°41'29.17"- 97°11'40.99", N 16°19'7.74"- 19°28'32.52"), is home to small remaining wild elephant populations. Previous studies, such as

Leimgruber et al. (2011), have identified eight small areas connected by forest corridors. Especially, these areas are critical for the survival of those wild elephant subpopulations (estimate 200-240). Alongside the foothills of Bago Yoma, Myanma Timber Enterprise (MTE) operates timber elephant camps, with a total of 416 individuals as reported in 2022 (MTE report unpublished data, 2022). This region is significant for both wild and semi-captive elephants. However, it is essential to consider the context of the populated lowlands surrounding Bago Yoma, which supports 80% of Myanmar's human population. The vast agricultural lands surrounding the mountain ranges are primarily covered by mixed deciduous forests, as noted in studies like Piazza et al. (2007). Within our study area, the establishment of the North Zamari Wildlife Sanctuary in 2014 stands out as a dedicated effort for the conservation of endangered Asian elephants, as recognized by the Ministry of Natural Resources and Environmental Conservation (MONREC, 2015). This sanctuary plays a crucial role in the broader initiative to protect and preserve the dwindling population of Asian elephants in the region.

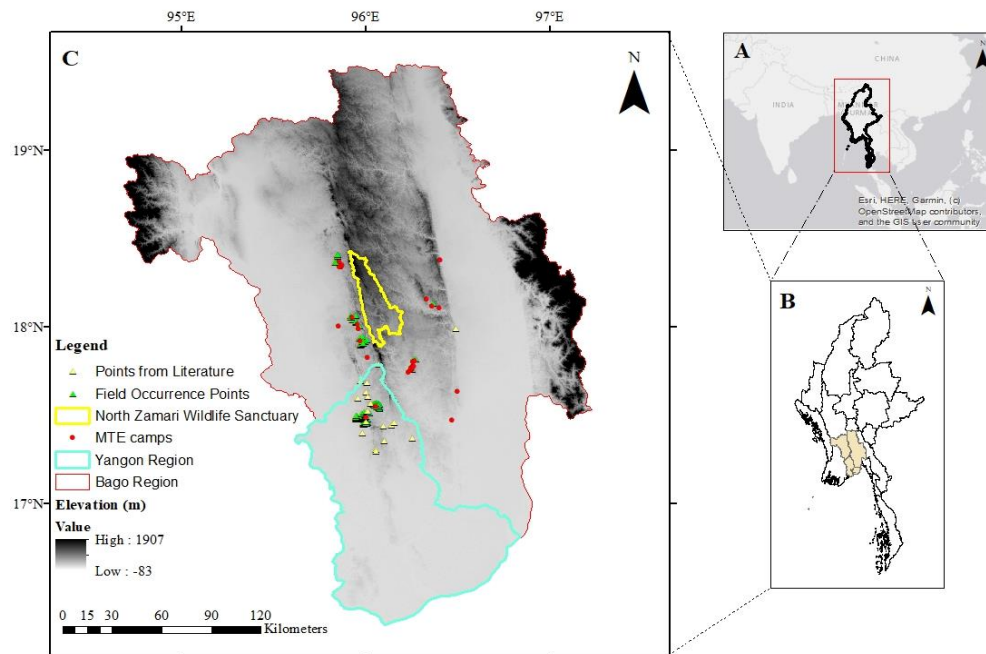


Figure 1 Study Area Map, showing the location of Myanmar in the continent of Asia (1-A), the location of the study area in Myanmar (1-B), and the extent of the study area showing different altitudes, timber elephant camps, the wildlife sanctuary, and presence points from field observations and the literature (1-C)

From February to April 2022, MTE managed approximately 3,000 captive or semi-captive elephants primarily used for timber extraction (Crawley et al., 2020). These elephants, characterized as semi-captive by Seltsmann et al. (2018, 2019), operate under mahout supervision during working hours but forage independently in nearby forests, engaging in natural behaviors such as mating with both semi-captive and wild elephants. Following the nationwide logging ban in 2016 (extended to ten years in the Bago Yoma region), many elephants retired and were housed in forest-based camps that overlap with wild elephant distributions (Khai et al., 2020).

A semi-structured questionnaire survey consisting of 42 questions was administered to mahouts from February to April 2022 to investigate the social behavior and spatial movement of semi-captive elephants and the environmental conditions of their habitat based on mahouts' expertise. Conducted in the local language, the survey captured observations on elephants' tendencies for solitude, sociability, mingling, and interactions with wild counterparts.

Responses, recorded as Yes or No, provided insights into the social dynamics and preferences of semi-captive elephants. The survey covered 140 female and 130 male elephants, aged 4 to 78 years (median: females 18 years, males 15 years), residing in their natural habitat. A total of 270 mahouts rated these elephants, with most mahouts having up to five years of experience (median: three years, range: 1 month to 26 years). Mahouts independently provided ratings to ensure unbiased results. Personality traits, including "solitary," "sociability," and "aggression," were defined based on established studies (Dammhahn & Kappeler, 2009; Gartland et al., 2021; Holekamp & Strauss, 2016) and used to classify observed behaviors (Table 1). Experiences with wild elephants (e.g., fighting, mingling, and mating) were defined as per Table 2.

Table. 1 Personality traits according to behavioral observations

| <b>Personality</b> | <b>Behavioral Observations</b>                                                                                                 |
|--------------------|--------------------------------------------------------------------------------------------------------------------------------|
| Solitary           | Solitary – an individual tends to maintain separate territories or temporal avoidance                                          |
| Sociality          | Accept_Mingling – an individual tends to accept mingling proposals from other semi-captive elephants regardless of sex and age |
|                    | Mingle_both_sexes – an individual tends to mingle with other semi-captive elephants regardless of sex and age                  |
|                    | Mingle_male – an individual tends to mingle with male semi-captive elephants only                                              |
|                    | Mingle_female – an individual tends to mingle with female semi-captive elephants only                                          |
| Aggression         | Aggressive_both_sexes – an individual tends to attack other semi-captive elephants regardless of age and sex                   |
|                    | Aggressive_to_male – an individual tends to attack male semi-captive elephants only                                            |
|                    | Aggressive_to_female – an individual tends to attack female semi-captive elephants only                                        |

Table 2 Semi-captive elephants' experience with wild elephants in their habitats observed by their mahouts

| <b>Experience with wild elephants</b> | <b>Mahout observation</b>                                                                     |
|---------------------------------------|-----------------------------------------------------------------------------------------------|
| Mingle_wild                           | Mingling with wild elephants in their habitats regardless of group members observed by mahout |
| Mating_wild                           | Mating with wild elephants in their habitats observed by mahout                               |
| Fighting_wild                         | Fighting with wild elephants in their habitats observed by mahout                             |

Statistical analyses employed the psych package in R software. Sample adequacy was measured using the Kaiser-Meyer-Olkin (KMO) test, while Bartlett's sphericity and Steiger's tests assessed the correlation matrix fit for factor analysis (Budaev, 2010; Seltsmann et al., 2018; Shrestha, 2021). Variables with low KMO values or no variance were excluded. Factor analysis



was conducted to understand underlying dynamics, followed by binomial logistic regression models (glm function) to evaluate the effect of personality traits on mahouts' reported interactions with wild elephants. Multicollinearity was addressed by removing variables with high variance inflation factors (VIF). Refined models underwent Type III analysis of deviance, and model selection using the dredge function identified the best models based on AIC values. Significant predictors were visualized using ggplot, with predictors achieving p-values < 0.01 highlighted. The plots revealed the relative influence of each personality trait on semi-captive elephants' experiences with wild elephants.

#### 4. Results

In this section, we evaluated the KMO values of each variable in the data set (Table 3) and the overall KMO value of sampling adequacy of the data set is 0.61 (Table 4), indicating that the sampling is adequate (Field, 2000; UI Hadia et al., 2016).

Table 3 Kaiser-Meyer-Olkin (KMO) value of each variable

| Variable              | KMO value |
|-----------------------|-----------|
| Solitary              | 0.59      |
| Accept_Mingling       | 0.58      |
| Mingle_both_sexes     | 0.88      |
| Aggressive_both_sexes | 0.82      |
| Aggressive_to_male    | 0.39      |
| Mingle_wild           | 0.60      |
| Mating_wild           | 0.52      |
| Fighting_wild         | 0.48      |

The strength of the correlation of the data set was measured by a Bartlett Test of Sphericity. Both Bartlett's Test of Sphericity and Steiger's Test for the personality traits and experience of semi-captive elephants with wild elephants are statistically significant (Table 4), supporting the factorability of the correlation matrix. The trait scores are correlated; therefore, we reject the null hypothesis that the original correlation matrix is an identity matrix. To be specific, the variables are not orthogonal. The significant value < 0.01 indicates that a factor analysis may be worthwhile for the data set. The findings from the binomial logistic regression analysis revealed significant associations between certain personality traits of semi-captive elephants and their propensity for engaging in fighting encounters with wild elephants within their habitat. Specifically, personality traits such as sociality (Mingle\_both\_sexes), and solitary demonstrated a marginally significant impact on the likelihood of such interactions with p-values of 0.06 and 0.02 respectively. Notably, the personality trait of aggression (Aggressive\_to\_male) emerged as the most influential factor, exhibiting a significant p-value below 0.01 (Figure 2). Furthermore, the personality trait sociality (Accept\_Mingling) emerged as pivotal for semi-captive elephants in their interactions with wild counterparts, highlighting its importance in facilitating mingling behavior with a p-value less than 0.01(Figure 2).

Table 4 Kaiser-Meyer-Olkin (KMO), Bartlett's Test, and Steiger's Test

|                                                 |                   |          |
|-------------------------------------------------|-------------------|----------|
| Kaiser-Meyer_Olkin Measure of Sampling Adequacy |                   | 0.61     |
| Bartlett's test of Sphericity                   | Approx.Chi Square | 780.5876 |
|                                                 | Df                | 28       |
|                                                 | Sig               | 0.00     |
| Steiger's test                                  | Approx.Chi Square | 780.59   |
|                                                 | Df                | 28       |
|                                                 | Sig               | 0.00     |



Figure 2. Coefficients of personality traits of semi-captive elephants in predicting models of fighting and mingling experience with wild elephants in their habitats

## 5. Discussion

Beekman and Jordan (2017) emphasized the potential of animal personality research to yield novel insights into behavioral ecology, while de Azevedo and Young (2021) underscored its significance as a fundamental aspect of animal conservation. The integration of personality assessment into the study of animal translocation gained traction following a notable study on reintroduced swift foxes (*Vulpes velox*) in Canada, where survival rates were found to be correlated with personality traits: bolder individuals exhibited shorter lifespans compared to their shyer counterparts (Bremner-Harrison et al., 2004). After this seminal research, there has been a growing consensus within the scientific community advocating for the inclusion of personality assessment in translocation and animal release programs (McDougall et al., 2006).

Our analysis of questionnaire survey data revealed a significant association between the personality trait of aggression and their likelihood of engaging in conflicts with wild elephants within their habitats, independent of age and gender. This finding is corroborated by a comprehensive review conducted by Briffa et al. (2015), which synthesized evidence from 16 studies indicating that aggression plays an important role in contest behavior, wherein animals compete over limited resources such as mates, food, or territory. However, some studies

showed that aggressive animals reproduce more when compared to shyer individuals (Schuett et al., 2010; Herdegen-Radwan, 2019). Additionally, our research indicates that the higher likelihood of conflicts with wild elephants among semi-captive individuals showing aggressiveness towards males may be due to the presence of predominant male wild elephants than females in the area. This insight was derived from discussions with mahouts regarding the movement patterns of wild elephants nearby.

Meanwhile, mingling with wild elephants among semi-captive individuals is influenced by the personal trait of sociality that is being likely to accept mingling proposals from both sexes. This observation finds support in the comprehensive review paper by Pavez-Fox et al., (2022), which highlights the association between sociality and diminished injury risk in group-living rhesus macaques (*Macaca mulatta*). In addition, Bond et al. (2021) marked the survival benefits associated with female giraffes (*Giraffa camelopardalis*) engaging in frequent mingling with other females, despite the composition change of group members. Their study underscores the significance of sociality over various non-social factors in shaping survival outcomes.

However, our analysis was unable to ascertain the influence of specific personality traits of semi-captive elephants on their mating experience with wild counterparts. This limitation may stem from the elusive nature of mating events, which are primarily nocturnal and occur when semi-captive elephants roam freely in forested areas beyond the observation of mahouts. Confirmation of mating encounters is challenging, with only a subset of individuals, predominantly females, observed to engage in such behavior during temporary associations with wild elephants and vanish for some time. These vanishing events often call for mahouts to follow them and ensure the safe return of the semi-captive elephants to their camps. Consequently, their mahouts had a chance to find out whether their elephants were having intercourse with wild elephants or not.

Furthermore, the diversity of personality traits examined in our study was limited due to inadequacies in the design of our questionnaire survey, which primarily relied on subjective observations provided by mahouts based on their experience and familiarity with the elephants under their care. For example, Seltsmann et al. 2018 labeled three personality traits in Asian semi-captive elephants as Attentiveness, Sociability, and Aggressiveness.

## 6. Conclusion

In conclusion, we observed a significant correlation between certain personality traits, such as aggressiveness towards male elephants, and the likelihood of fighting experience with wild counterparts. This finding sheds light on the importance of considering individual differences in social behavior when managing semi-captive elephant populations, particularly in regions where the reinforcement program is proposed to be performed. Therefore, the personality of the candidate also contributes to the success of the reinforcement program and plays a fundamental role in the candidate selection. This step can collectively contribute to a more comprehensive and effective approach to safeguarding the Asian elephant population in Southeast Asia.

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