11.1 IMPORTANT CONCEPTS IN DARTING

11.1.1 Ballistics

Ballistics is the study of the natural laws governing the performance of projectiles and the use of these laws to predict their performance. Apart from the basic construction, shape and length of a dart, the main controlling factor in dart behaviour upon impact is the velocity at which the dart is travelling. Energy potential is dependent on velocity and dart mass. Velocity affects both trajectory and dart stability during flight. Generally, the faster the dart, the flatter the trajectory and the greater the impact energy. Too much impact energy is a disadvantage when darting animals, as the dart may break, bounce out, blow back or even penetrate into the tissues, often causing severe tissue damage. Consequently, it is often more suitable to ‘lob’ a dart at an animal, especially when close by, in order to reduce this impact energy. The operator, therefore, needs to practise with the chosen system in order to become familiar with distance estimation and trajectory for different types, sizes and weights of darts, and different charges or variable settings on projectors.


11.1.2 Dart impact comparison

<table>
<thead>
<tr>
<th>Dart</th>
<th>2 ml</th>
<th>3 ml</th>
</tr>
</thead>
<tbody>
<tr>
<td>TEL-INJECT/DAN-INJECT(^a)</td>
<td>5.72 g</td>
<td>7.9 g</td>
</tr>
<tr>
<td>PNEU-DART</td>
<td>9.5 g</td>
<td>11.0 g</td>
</tr>
<tr>
<td>PAX-ARMS</td>
<td>ND</td>
<td>13.95 g</td>
</tr>
<tr>
<td>AEROJECT</td>
<td>12.7 g</td>
<td>15.7 g</td>
</tr>
<tr>
<td>VARI RANGE</td>
<td>14.2 g</td>
<td>16.2 g</td>
</tr>
<tr>
<td>CAP-CHUR &amp; SIMMONS TAIL PIECE(^b)</td>
<td>16.55 g</td>
<td>18.6 g</td>
</tr>
<tr>
<td>CAP-CHUR</td>
<td>17.2 g</td>
<td>19.55 g</td>
</tr>
</tbody>
</table>

All darts were filled with water and ready to fire. The weights represent the mean of three separate darts.

Table 11.1: Weight comparisons of commercial darts (weight in grams)

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Figure 11.1: Weight comparison between two darts commonly used to immobilize wild animals

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Dart Impact = \( \frac{1}{2} \text{mass} \times \text{velocity}^2 \) (KE = \( \frac{1}{2} M \times V^2 \))
Table 11.2: A decrease in weight is directly proportional to a decrease in impact. For example, if velocity is constant at 300 feet/second then the impact is as shown above.

Note: A Telinject produces 1620 ft pounds and a Cap-Chur 4010 ft pounds – a significant difference in terms of impact energy and potential damage to an animal!

Use the lightest dart that is compatible with your operations. Use the lowest liquid volume (thus the most concentrated drug formulation possible), and reduce velocity to the lowest compatible setting. To do this, you must know your equipment and practise with it. A 3 ml Pneu-Dart at 300 feet/second = 2 250 foot pounds; at 200 feet/second = 1 000 foot pounds.

Many types of guns and various dart sizes exist. Some operators will try to standardize their field equipment at .50 calibre, so all their equipment and materials are interchangeable or they may use a system that has interchangeable barrels such as the Dan-Inject.

Newer darting systems claim to be accurate to 100 metres. The authors have serious doubts about darting any wild animal (with the exception, maybe, of elephant) at that distance. The maximum safe darting distance in our opinion is 40 metres, with 60 metres exceptional!

DART SYSTEMS AND CONCEPTS

11.2 TAILPIECES AND NEEDLES: AN OVERVIEW

11.2.1 Tailpieces

The trajectory of a dart is determined by a number of factors already discussed but it is the tailpiece that imparts the drag that reduces the tendency to tumble in the air and determines whether the dart projectile flies true. There are several different tailpiece designs, most of which have been designed to complement a particular dart’s ballistic properties. Materials used to make tailpieces vary from yarn through to finned plastic (see Figure 11.2; note that the Simmon’s tailpiece is also referred to as Zite-Flite). The yarn tailpiece is probably the most basic and darts with this design are functional (for example, Cap-Chur). Advantages of this design include durability and simplicity but yarn can adversely affect dart flight if it is ragged and

![Figure 11.2: A variety of different tailpieces are available from cloth through to plastic.](image-url)
darts drift. Figure 11.15 illustrates the technique for loading Dan-Inject and Telinject darts. It is possible ensure that the dart is pressurized with air if it has been stored after pressurizing by testing the back plunger resistance with a probe. Darts may fail to hold pressure with repeated usage. The Dan-Inject system is far more robust than Telinject, with the darts constructed of stronger and more durable plastic. Both are innovative systems with many applications. The Telinject blowpipe is a finely crafted, expensive and somewhat delicate instrument, but we have experienced some durability problems under field conditions. An adjustable-velocity, light and accurate gas-powered rifle (Vario and GUT50) shoots a higher velocity stronger Telinject dart. This system is the choice of some large zoos that do a lot of darting on very valuable animals, but it is fairly expensive. If the lighter dart is used in the high-velocity system, it will fracture and fail. More recent models such as Dan-Inject's JM2 rifle represent state-of-the-art darting equipment (see Chapter 12), with a revolutionary design, ease of use and accuracy. The use of state-of-the-art aiming systems such as adjustable and battery-operated red dot point scopes have made these guns very versatile. The addition of a .50 calibre barrel (13 mm non-rifled) allows the firing of Cap-Chur type darts. In this instance, the JM2 should have a high pressure gauge fitted – up to 25 bar – in order to be able to fire heavy darts up to distances of 40–50 meters. Note that Pneudart (C type) cannot be shot out of this barrel as they tend to tumble and/or fly erratically – the un rifled barrel may be the problem.

A blowpipe system, using low-velocity Telinject darts, is commercially available from Maxiject by Addison Biological Laboratory, Fayette, MO 65248 USA. We have minimal field experience with this equipment, though it appears to be high quality and accurate at short distances. Dan-inject markets a blowpipe system (Model Blow 125 cm and 180 cm).

**Some important notes and instructions on the use of Dan-Inject (or Telinject)**

Figure 11.15 illustrates the loading technique for a Dan-Inject dart. To unload a Dan-Inject dart, note the following:

1. Ensure that the needle is covered with a protective sleeve.
2. Remove the red tailpiece from the dart.
3. Depress the blue or red plunger in the rear air pressure chamber using the wire provided.
PWE darts are found in two main classes:

1a. Plastic reusable darts
   - High impact nylon 11 mm and 13 mm darts, which shoot through all standard guns (for example, Telinject, Dan-Inject, etc.).
   - They come in sizes from 1 ml to 5 ml.
   - They operate with air pressure in the back compartment.
   - 3 ml up to 5 ml all take radio-transmitters.

1b. One-time use
   - 17 mm range of plastic darts for treatment, dipping, and vaccination.

2. Aluminum darts
   - 13 mm and 17 mm darts that work with explosive charges to inject drugs (like a Palmer). Dart volumes are from 1 ml up to 30 ml.
   - They come in sizes from 1 ml up to 30 ml.
   - 3 ml up to 5 ml all take radio-transmitters.

They manufacture two different dart guns. They are fully customizable in terms of: grip, length, and colours.

- They work with CO₂ like a Dan-inject and have 13 mm, 11 mm and 18 mm barrels.
- The large bore 18 mm barrel has been adapted to shoot paintballs (ceramic, rubber, plastic, paint filled and ectoparasite balls) and this barrel shoots a range of 17 mm darts. These are specifically treatment darts from 2 ml up to 30 ml capacity.

PWE also manufacture needles and pole syringes.

11.12.3 Home-made darts

A dart design discussed by Fowler (1978, 1983) can be projected from a home-made blowpipe at reasonable ranges with accuracy. It is made from commercially available Monoject or other brands of plastic syringes. It is extremely light, inexpensive and reasonably reliable. Fowler’s article should be consulted for construction details. Another way of making blowpipe darts from plastic syringes is described by Bernard and Dobbs, J. Am. Vet. Med. Assoc., 1 Nov, 1980, pp. 951–953.

REFERENCES
